ONE DOLLAR A YEAR · TEN CENTS A COPY:

CONTENTS . 340
ADV'G. INDEX XXII

MACHINERY:

VOL. 3. Nº 11. PUBLICATION OFFICE 411-418 PEARL STREET NEW YORK CITY. JULY: 1897.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

Every foreman says: When you buy a file, see that it has

Good teeth and

The "Arcade" has 'em.

Made by
The Arcade File Works,
97 Chambers St., New York.
118 Lake St., Chicago.

Works:
Anderson, Indiana.

Write for a copy of "Facts and Suggestions About Files," which every one should have who uses files on his work, or is at all interested in the subject. In addition to many practical points on the use of files, the book contains some 60 pages of section-lined paper especially adapted for mechanical memoranda. It will be sent to any one who addresses the New York office, 97 Chambers Street, and mentions this paper.

Another point of equal importance is

A good temper.

The "Arcade" has it; every user says so.

Built Vertical and Horizontal, with 4, 8 and 14 Spindles.

We Build

Radial Drills, Multiple Spindle Drills

and

Vertical Boring Machines.

Write us for prices and circulars.

Baush & Harris Mch. Tool Co.

Springfield, Mass.

The Standard Tool Company, Cleveland, Ohio.

MANUFACTURERS OF

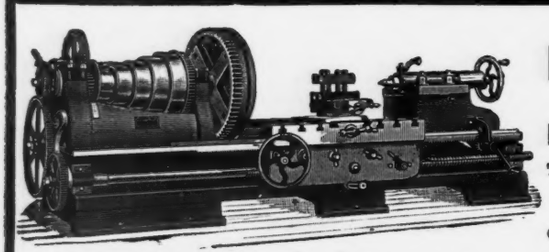
London Eng., Burton Griffiths & Co. 158 Queen Victoria St.

Paris, France, Barton Fils, 68 Rue Des Marais.

TWIST DRILLS

Bit Stock Drills, Taper and Straight Shank Drills, Screw driver Bits.
Sockets and Chucks, Hand and Shell Reamers, Taps, Milling Cutters.
Morse Taper Reamers, Square Shank Drills for Ratchets, also
Spring Cotters and Flat Spring Keys.

SEND FOR CATALOGUE.



NEW PATTERN

Engine Lathes,

17-INCH TO 64-INCH SWING.

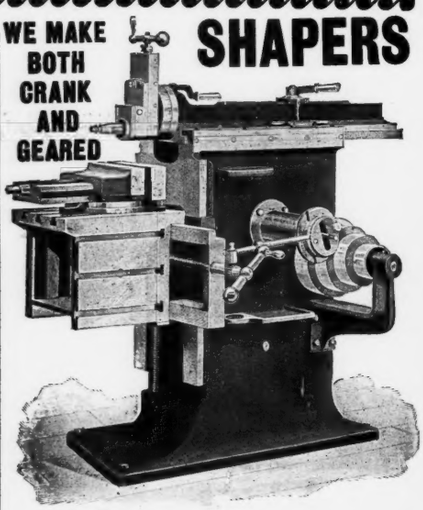
Back and Triple Geared.

Two acres of floor space devoted entirely to the manufacture of Lathes.

Cuts, Photographs and Prices furnished on application.

FIFIELD TOOL CO., Lowell, Mass., U. S. A.

WE MAKE BOTH CRANK AND GEARED SHAPERS

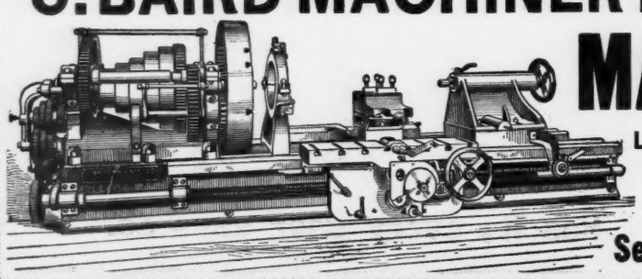


FOUR SIZES OF THIS STYLE, 12, 16, 20, 25 INCHES, WITH ALL THE DESIRABLE FEATURES.

John Steptoe & Co., Cincinnati, O.

Sole European Agents: Selig, Sonnenthal & Co., 85 Queen Victoria St., London, E. C.
Sole Agent in Germany: E. Sonnenthal, Jr., 5. Neue Promenade, Berlin.
The Cooke Machinery Co., 163 Washington St., New York City.

U. BAIRD MACHINERY CO., PITTSBURG, PA.



MACHINE TOOLS.

LATHES, PLANERS, SHAPERS, HOISTS,

MILLING MACHINES, RADIAL DRILLS, GEAR CUTTERS, DRILL PRESSES.

Send for list of SECOND-HAND TOOLS.

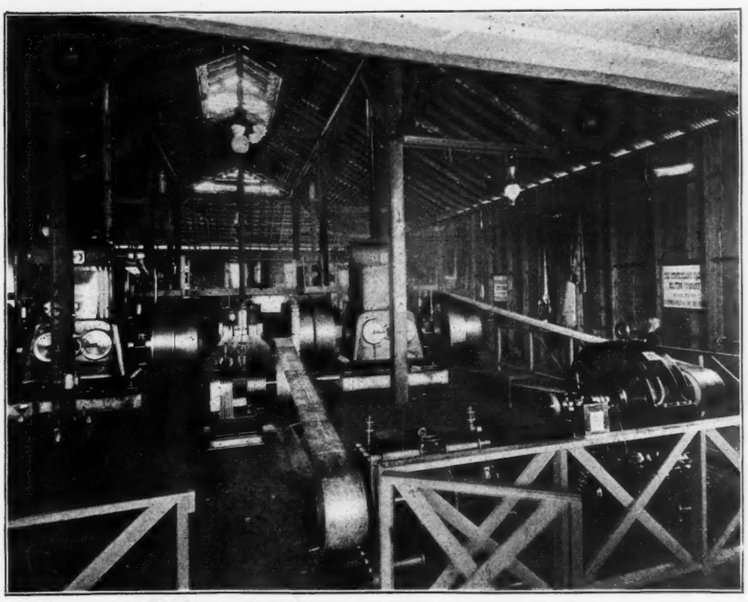
MACHINERY.

VOL. 3. July, 1897. NO. 11.

NASHVILLE EXPOSITION NOTES.

HENRY MONK.

THE Tennessee Centennial and International Exposition opened its gates on the 1st of May, as advertised. The opening day was like many other opening days at other expositions, with the exception that this exposition was in a more complete state than any of its predecessors. Its completion would have been entire, but for the late arrival of some exhibits, and a few small concessionary buildings started too late.



INTERIOR OF ENGINE ROOM

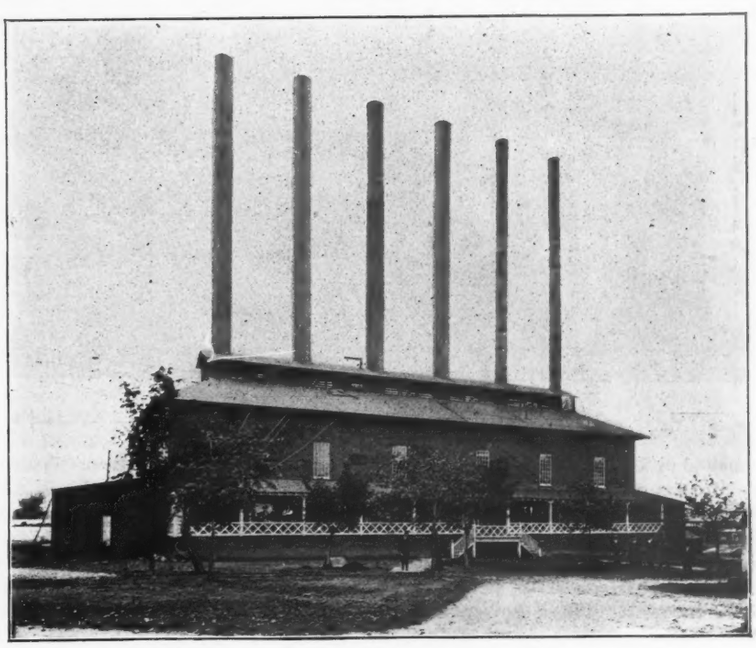
The engineering, machinery and electric departments were right on time, which is something that has not a precedent in exposition history. The whole of the power and exhibit plant, in the power house and Machinery Hall, was in operation on the evening of May the 1st, sending out a flood of light over the grounds and buildings. The lighting system was superb, and a magnificent result was obtained. To have looked on the power plant and then on the magnificent effectiveness of the lighting system, one might have thought that the plant had been running for years instead of so many minutes, and every engine, boiler and electric machine has continued to give the best satisfaction and results up to the present, without the slightest change or mishap.

The steam plant is in a separate boiler house, and consists of six Climax boilers built and supplied by the Clonbrock Steam Boiler Co., of Brooklyn, N. Y. Four of these boilers are 500 HP. and two are 250 HP. each, making a total of 2 500 HP. The boilers are very efficient and very rapid steamers. All the steam pipe, valves and fittings in connection with this plant are extra heavy, and are guaranteed at a working pressure of 150 pounds per square inch. The steam pipings are laid with a down grade right from the boilers until they arrive at the foot of the engine foundations, then all the condensation is separated and returned direct to the boilers, the steam pipe then rises vertically about level with the engine throttle valve, the connection is then made with a pipe, forming a complete half circle, which rises about four or five feet above the throttle valve. This gives a very nice finish and improves the appearance of the engines.

The electric lighting power plant is also separate from the boiler house and Machinery Hall, and consists of five engines and eleven electric generators. There are four 400 HP. Westinghouse compounds and one high speed Beck engine of 50 HP. The Westinghouse compounds pull the following machines: Six general electric alternators, capacity 130 KW. each, and two Brush arc machines, capacity 125 lights each; one Western electric arc machine, capacity 100 lights; one Western electric arc machine, capacity 80 lights; the Beck engine pulls one Wood arc machine, capacity 40 lights; making a total of 470 arc light capacity, and the alternators are carrying 16 000 incandescent lights.

In Machinery Hall there are five engines, one 500 HP. Hamilton Corliss engine, one Lane & Bodley Corliss engine of 500 HP. and a 50 HP. Lane & Bodley flat slide valve engine. There is also a 100 HP. Imperial direct connected high speed engine, and one 150 HP Phœnix high speed direct connected engine.. The engines are all doing good service, and give no trouble in operation. The Imperial engine is connected direct to a Triumph power machine of 500 volts, with a capacity of 75 KW. The Phœnix engine is directly connected to a Western electric direct current 110 volt machine, with a capacity of 100 KW.

The Lane & Bodley Corliss engine has a new feature in connection with the valve motion, which consists in having two eccentrics, one to operate the steam valves and the other to operate the exhaust valves independently. The object of the maker in doing this is to dispense with wrist plate and at the same time obtain a wider range of cut-off than can be obtained by the old method. The dash pots on this engine are also ele-



BOILER HOUSE.

vated about 18 inches above the foundation, which makes them very convenient to get at. And there are some other new features in connection with this dash-pot arrangement which makes them very active and noiseless.

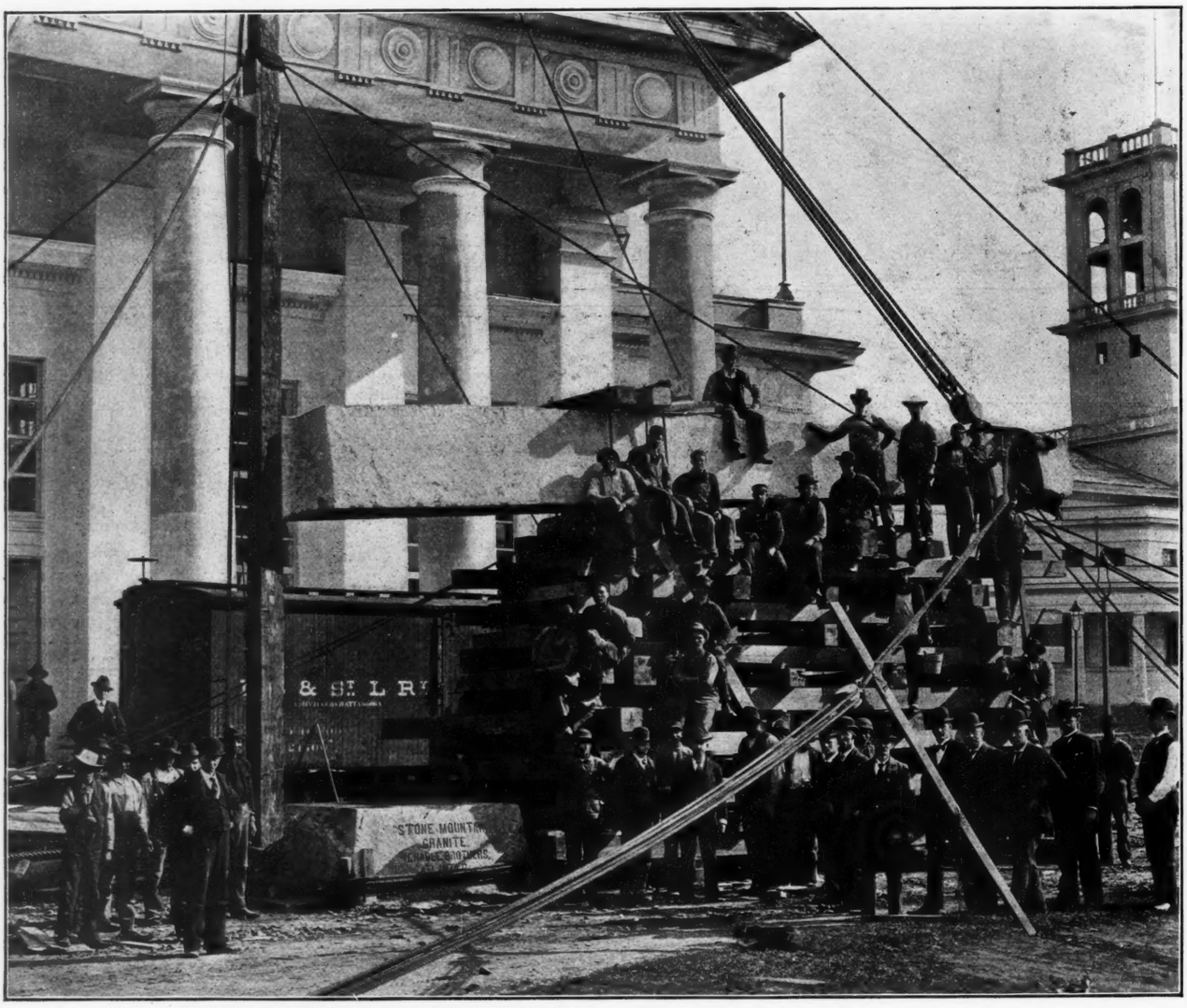
The Lane & Bodley Corliss engine turns the line shafting on the east side of Machinery Hall, and gives power to all exhibitors on that side of the building. The Hamilton Corliss engine turns the shaft on the west side of the building, and gives power to all exhibitors on that side, and turns two electric dynamos, one for direct current, which is a Wood machine of 110 volts, with a capacity of 50 KW., and the other is a general electric power machine of 500 volts with a capacity of 60 KW. The Phœnix engine is connected direct to a Western electric direct current machine with a capacity of 100 KW. The Imperial engine is connected direct to a Triumph power generator, which has a capacity of 75 KW. The Lane & Bodley flat slide valve engine is belted on a Triumph electric generator, which is used for partial decorating of Machinery Hall.

Among the machinery in the power plant are two Brush arc light generators, which represent the latest pattern of that well known machine. Aside from the qualities which have made that machine prominent for so many years, is a new feature which more than strengthens the reputation which it already holds. The feature referred to is the multi-circuit connection, by which it is possible to run three separate circuits from the one machine. It is not necessary to run three circuits, for you can run one, two, or three and divide the load any way you please, so long as you do not run above the rated capacity of the machine. The usefulness of this method can readily be seen when the highest voltage found on the machine is practically the voltage of the highest circuit run, thus making a very safe method of running lights from a large dynamo, absolute flexibility of handling circuits, the use of large units with corresponding increase of efficiency, saving of floor space, oil, belts, shafting, pulleys and attendance.

There is a very fine collection of machinery exhibits in Machinery Hall. The Laidlaw-Dun-Gordon Company, of Cincinnati, O., pumping machinery, which consists of a fine class of many various kinds of pumps, such as ammonia, air, and circulating pumps, bilge and boiler-feed pumps, compound condensing pumping engines, drainage, electric and fire pumps, hydraulic elevator pumps, and compound air compressors, all connected and in full operation.

The Brown & Sharpe Mfg. Co., of Providence, R. I., are well represented in their exhibit of some of their finest class tools and machines. The Norton Emery Wheel Co. have also a very fine collection of emery wheels and their appurtenances on exhibition. The Acme Machinery Co. is well represented with their machines. Also the Builders' Iron Foundry, of Providence, R. I., and the Hickok Paper Machine Co., of Harrisburg, Pa. The Hascall Steam Generator Co., of New York, have some attractive working models and a full sized attachment. The Otto Gas Engine Co. have a very fine display in having a number of their engines in full operation, and all of various designs and sizes. The Enterprise Soap Works, of Nashville, Tenn., have an excellent working exhibit, showing the manufacture of various soaps, which calls considerable attention and seems to interest visitors very much. E. B Holmes Machinery Co., of Buffalo, N. Y., have an excellent display of some of their fine wood working machinery all in full operation.

Houston, Stanwood & Gamble, Cincinnati, Ohio., have three of their engines on exhibition. The Wolf Co., Chambersburg,



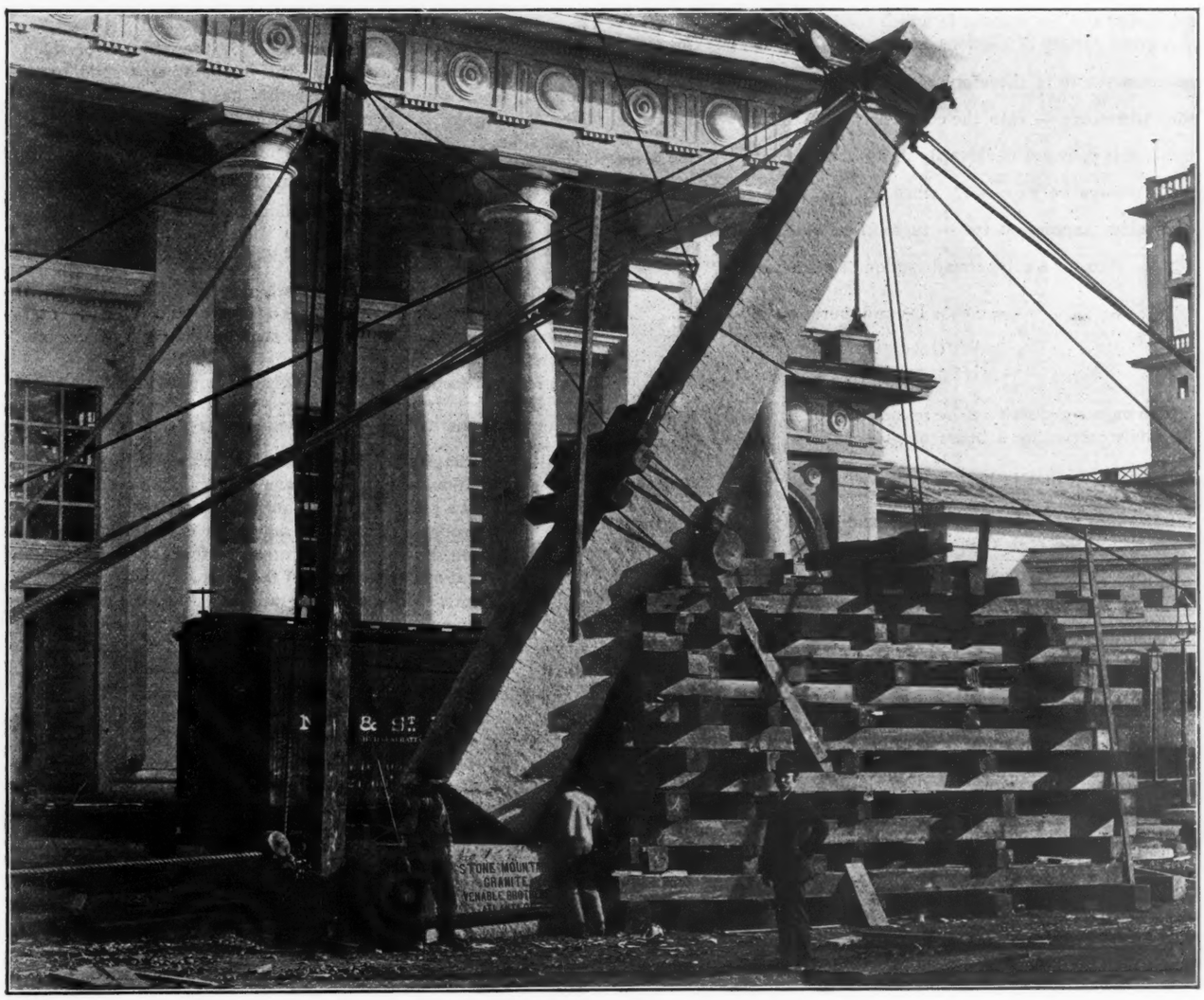
GETTING READY TO PUT THE GRANITE SHAFT IN PLACE.

Pa. have a very fine exhibit of flour mill machinery. The American Fire Engine Co. have two of their very fine fire engines on exhibition with their appurentances. The National Tube Co. have a very large exhibit of their tubing. Charles A. Schieren & Co., New York, have a very fine leather belting display. The Dodge Mfg. Co. have an excellent display and interesting exhibit of split wood pulleys, etc.

There is also cotton and woolen machinery in full operation, and silk weaving from various exhibitors and weavers. Henry Disston & Sons, saw manufacturers, have a very fine exhibit of their goods. The Southern Belting Co., of Atlanta, Ga., also have a creditable display. The Frick Co., Waynesboro, Pa., have an interesting ice machine on exhibition. W. B. Barry, of Indianapolis, is well represented with an excellent display of saws. The Laflin & Rand Powder Co., New York, have an excellent exhibit. The W. T. Adams Machinery Co., Memphis, Tenn., have an exhibit of two saw-mill engines and saw-mill machinery. The Model Flour Mill, of Nashville, Tenn., have a very creditable display. The Hancock Inspirator Co , Boston, Mass., are well represented. One of the most interesting exhibits to those who are connected with, or interested in, the cotton industry, pertaining to the ginning, baling and transporting of of cotton, is the exhibit of the American Cotton Compress Co. The new system takes the seed cotton from the producer, cleans, gins, and carefully prepares the cotton for market, densely compresses the bale into a compact cylinder, and securely protects it with a closely-woven covering. It does away with the jute bagging and ties, the new covering weighing 3½ pounds, instead of the former 21 and 28 pounds. The round bale is practically fireproof, as 'it does not contain enough oxygen to support combustion.' It occupies, comparatively, only 60 per cent. of the warehouse space. The material saving in storage and in stowing it away in cars and ships for transportation, is very apparent, as a car can now be readily loaded with 60,000 pounds of cotton; whereas, in the past, the average weight carried in cars with the ordinary bale was about 35,000 pounds, and its great advantages to transportation companies is very apparent.

H. M.

[The photographs shown herewith illustrate some work that was done at the Tennessee Centennial International Exposition shortly before it was opened, and no doubt will be interesting to all concerned in the raising or erecting of heavy weights. The photographs show the methods by which a solid granite shaft of stone 36 feet 9 inches long, 4 feet square at the base and 2 feet 10 inches at the top, weighing a little over 70 000 pounds, was raised and placed on a pedestal of granite 6 feet square and 4 feet above the ground; as erected, it now stands 40 feet 9 inches high. To look at the dimensions and weight, some would think—well,



ALMOST IN PLACE—THE SUCCESSFUL ENDING OF A GOOD JOB.

that is not much of a job, and neither it is, provided there is a 70 000 pound crane having sufficient drift, but when you have no crane and no tackle that will lift over 15 000 pounds and the work must be done, it then condenses itself into a piece of nice engineering, or in other words—"brains over matter." The first photograph shows the shaft as it lays on blocking, where it has been raised by jacks to a height of 14 feet 6 inches, this in itself was nice work, to do it right. The shaft was then mounted on a trunion and securely clamped about 13 feet from the base. Nice measurement and mounting was required so that the base would land in the proper position, and at the same time to calculate the load on the tackle so that it would not exceed, at any time, 15 000 pounds. The shaft was raised in good form without the slightest hitch or anyone receiving a scratch. By special request, this piece of work was engineered and supervised by Mr. Henry Monk, Ass't.-Chief of Machinery of the Exposition.—ED.]

BEAM DIMENSIONS AND LOAD BY DIAGRAM.

HENRY HESS.

The general formula for determining the load a beam can carry within the elastic limit of the material, is given by Reuleaux and others as

$$P = \frac{C\,S}{L}\,\frac{J}{a}$$

in which

P is the load.

S is the greatest fibre stress.

L is the length.

$\frac{J}{a}$ is the modulus of resistance of the section, *i. e.*, the moment of inertia J divided by the greatest distance, measured perpendicularly, of any fibre from the neutral axis.

C is a coefficient determined by the way in which the beam is supported and the manner in which the load is applied.

A great variety of sections may be used all having the same modulus $\frac{J}{a}$, it is therefore rational to first solve for $\frac{J}{a}$, and then to resolve $\frac{J}{a}$ into the components required by the section used; this does not necessarily mean that numerical value of $\frac{J}{a}$ must always be expressed, since for the simpler sections the equivalent expression for $\frac{J}{a}$ in section dimensions may be inserted; thus for a solid round section of diameter D

$$\frac{J}{a} = 0.0982\ D^3 \text{ and therefore}$$

$$P = \frac{C\,S}{L}\,0.0982\ D^3$$

The values generally to be found are either the load that may be safely carried by a beam of given demensions, or the beam section $\left[\frac{J}{a}\right]$ that is best to carry a given load. From this it follows that the most convenient arrangement of a diagram will be to place the scales representing the load P and the section modulus $\frac{J}{a}$ at the sides, while the three factors C, S and L are represented by diagonal lines.

Turning to the diagram, the long portion is used to solve the general beam equation

$$P = \frac{C\,S}{L}\,\frac{J}{a}$$

Suppose a load of P = 13 000 is supported at the end of an overhung beam of length L = 125, that the maximum fibre stress S is not to exceed 5 000, and that the section modulus $\frac{J}{a}$ is to be found. The formula after transposition reads

$$\frac{J}{a} = \frac{P\,L}{C\,S}$$

As already stated the coefficient C is determined by the manner of supporting and loading the beam; its value is given as 1 opposite the skeleton sketch representing an overhung beam loaded at the end.

On the vertical left-hand scale find the value P = 13 000 and divide this by C by tracing it horizontally to intersection with the diagonal C marked 1; then multiply the result by L by tracing from the intersection just found vertically to intersection with that L diagonal marked with the length 125; the result is to be divided by the fibre stress S, which is done by tracing horizontally to the diagonal S marked 5 000; the value of $\frac{J}{a}$ is then vertically under the intersection with S in the lower scale, and reads 325. This value must now be resolved into its elements as determined by the shape to be used. Suppose this to be rectangular of width B and length H; the formula is

$$\frac{J}{a} = \frac{B\,H^2}{6}$$

This can be solved by the aid of the small portion of the diagram; either the width or the height must be assumed; let it be the width B and say this is 4. By transposition

$$H = \sqrt{\frac{J}{a}\,\frac{6}{B}}$$

$\frac{J}{a}$ was already found by the intersection with the 5 000 diagonal S; it is multiplied by $\frac{6}{B}$ by tracing vertically downward past the $\frac{J}{a}$ scale without stopping to take note of the numerical value of $\frac{J}{a}$ to intersection with the diagonal representing the width B = 4; this intersection is traced horizontally to the left to the scale H, which is divided logarithmically to read directly for square root values; H is found to read 22.1. Assume now that instead of having a rectangular section the beam is a solid round bar. Then the formula for the section takes the general shape common to all regular polygons, that is

$$\frac{J}{a} = K\,D^3$$

in which K is a coefficient determined by the number of sides, and D is the length of a side, or the diameter of a solid round section. The circle comes under this head, since it may be defined as a regular polygon having an infinite number of infinitely short sides. Instead of using the side whose infinitely short length cannot very well be expressed as a numerical value, the diameter D is taken. The proper coefficient K is given under the sketches of various simple sections; for the circle it is 0.0982.

To find the diameter D trace the value of $\frac{J}{a}$ found at the intersection with the S diagonal vertically downward to the diagonal representing the coefficient K marked 0.0982, and refer the intersection horizontally to the vertical scale at the right, where read the value D = 14.93.

As regards accuracy of the diagram compared with the usual arithmetical method: By the latter $\frac{J}{a} = 325$, the same value as found by the diagram. H is found to be 22.09, only $\frac{1}{20}$ of 1 per cent. smaller than by the diagram. By calculation D is 14.9, which is about 2 per cent. less than the value found by the diagram. It is probable that the average error is somewhat greater, especially when the diagonals referred to form but small angles with the verical or horizontal; but the error will easily be within allowable limits, while the diagram has the advantage over arithmetical computation of ease and rapidity and avoidance of all possible errors, such as saying that 2 × 2 are four and writing down 5.

Comparatively few diagonals have been drawn, in order to keep the diagram as open as possible and avoid the appearance of confusion incident to the crossing of many lines. Should it be desired to use values other than those marked, interpolation must be resorted to; but this is a very easy matter, for which division by the eye is quite sufficient. Take for example the bundle of diagonals representing the beam length L; the values represented are in a series of 25, and at first glance it would appear that the divisions do not progress uniformly as do the values. This is, however, only apparent, the eye being misled by the fact that the angles included by the diagonals decreased constantly. An examination of the vertical in which the diagonals terminate will show that the successive diagonals include equal increments of this vertical scale; in other words, uniformly increasing values of the diagonals are measured by uniformly increasing tangents. Interpolations are therefore to be made on a tangent; of course any tangent may be selected, but for convenience one is to chosen represented by some one of the traces that is divided between adjacent diagonals by the crossing traces into a number of parts that is a multiple of the desired division. Say for instance that a beam length of 80 is to be used; this lies between 75 and 100, $\frac{1}{5}$ of the space reserved from 75. On the last scale the one on which the diagonals terminate, are 7 divisions between 75 and 100; on the next heavy trace are 6, and on the next 5; therefore a diagonal drawn from the origin through the first of these divisions on this trace will represent the length 80.

On the diagram and throughout no terms such as lbs., inches, etc., have been used. It is obvious that any terms may be assigned to the scales, but these must be uniformly used throughout; thus if lbs. and inches are used all linear dimensions must be in inches, all areas in square inches, all weights in lbs., and all

compound terms such as maximum fibre stress are made up of these two, as lbs. per square inch.

The diagram may be used for both larger and smaller values than these given, as will be plain from the following example: Say that instead of a load of 13 000 as before, one of 130 is used; in the P scale this falls so low that its trace will not cut any C diagonals, even were these continued into the corner they would but form a confused mass at the height of P = 130; but the 13 000 value may be used as before, giving $\frac{J}{a} = 325$; but as 13 000 is 100 times greater than 130, the value found for $\frac{J}{a}$ must be divided by 100, making the true value 325.

Resolving this $\frac{J}{a}$ into its components is not quite so simple, as the complication of roots comes in. It is done by raising the scale value found to the proper power, pointing off the number of places added to P, and then from the result extracting the root, which is the required answer. Thus for H the true value would be equal to

$$\sqrt[3]{\frac{\text{scale value}^3}{n}} = \sqrt[3]{\frac{22.1^3}{100}} = 2.21$$

Here n is the number by which the actual value of P is multiplied to give the scale value used. For B the true value would be equal to

$$\sqrt[3]{\frac{\text{scale value}^3}{n}} = \sqrt[3]{\frac{14.93^3}{100}} = 3.22$$

From the length of the preceding description the conclusion might be reached that the diagram is confusing; trial will bring conviction to the contrary. Directions for use may be briefly stated as follows:

Find the coefficient for section and manner of loading and support, from the sketches. Trace from the scales to diagonals on lines parallel with the dotted example line shown. Find the desired values either at the scales or represented by diagonals passing through the intersection of the traces.

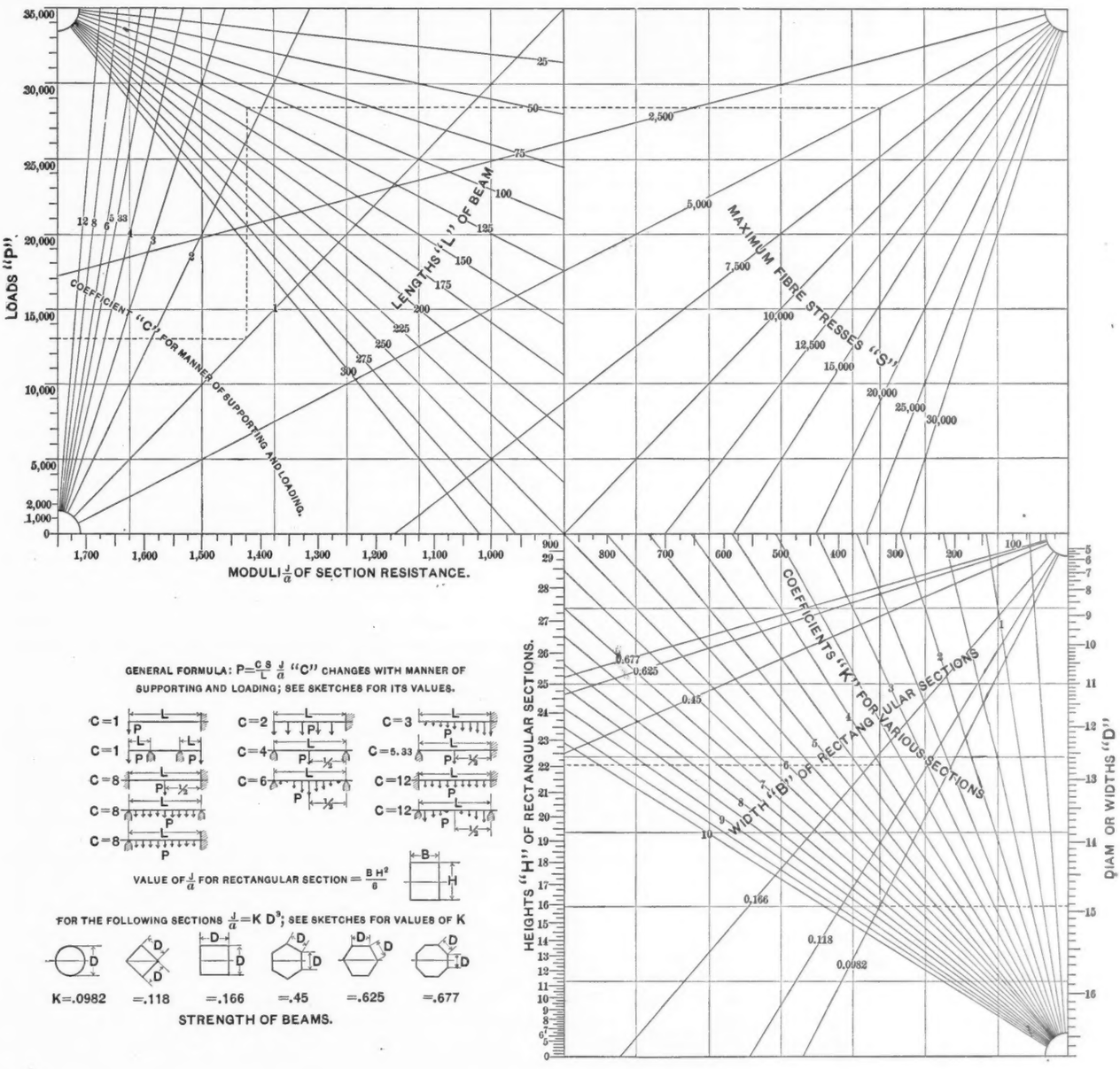

LOADS "P"
COEFFICIENT "C" FOR MANNER OF SUPPORTING AND LOADING.
LENGTHS "L" OF BEAM
MAXIMUM FIBRE STRESSES "S"
MODULI $\frac{J}{a}$ OF SECTION RESISTANCE.
HEIGHTS "H" OF RECTANGULAR SECTIONS.
COEFFICIENTS "K" FOR VARIOUS SECTIONS
WIDTH "B" OF RECTANGULAR SECTIONS
DIAM OR WIDTHS "D"
GENERAL FORMULA: $P=\frac{c}{L}\frac{s}{a}\frac{J}{a}$ "C" CHANGES WITH MANNER OF SUPPORTING AND LOADING; SEE SKETCHES FOR ITS VALUES.
C=1 C=1 C=8 C=8 C=8 C=2 C=4 C=6 C=3 C=5.33 C=12 C=12
VALUE OF $\frac{J}{a}$ FOR RECTANGULAR SECTION = $\frac{B H^2}{6}$
FOR THE FOLLOWING SECTIONS $\frac{J}{a}=K D^3$; SEE SKETCHES FOR VALUES OF K
K=.0982 =.118 =.166 =.45 =.625 =.677
STRENGTH OF BEAMS.

DIAGRAM OF BEAM DIMENSIONS.

ANOTHER METALLURGICAL WONDER (?)

A new metal (another white metal) called "vestadium," of beautiful appearance and great strength, has been discovered. It is said to be stronger and of more practical use than any other metal of the same specific gravity now known. It is claimed to be an alloy of aluminum, and of about the same weight as pure aluminum; that it is non-corrosive, resisting even sulphuric acid; that it is susceptible of a fine polish, never tarnishes, and requires no cleaning after being once polished. It is patented. It is to be hoped that fewer extravagant claims will be made for this metal than were made for aluminum, which was also said to possess these qualities, but which unfortunately have failed to materialize.

SPUR GEAR ARITHMETIC.—1.

ARTHUR B. BABBITT.

When we consider the number of gears used in machinery and the number of men employed in the manufacture of machines using gears, it is rather surprising to find men who are unable to find the outside diameter, having given the pitch diameter and pitch, or to find the distance between centers of two gears, having given the number of teeth and pitch, and similar problems. This is very often the case, and how a man can go on from day to day without exerting himself to find out the hows and whys, is a mystery.

I was approached recently by a man who wanted to know how to find the outside diameter of a gear of a certain pitch and number of teeth, and proceeded to show him, at the same time explaining the reason for my different calculations; and, after the problem was solved, asked him why he did not study the subject. He replied that he did get a book on gears once, but that it was filled up with algebra and he could not understand it on that account, but that he had some rules on the subject set down in a note book, only he did not have a rule which covered this case. Later he brought me the text-book which he had bought, and upon examination I found, as I had supposed, that the book contained no algebra, but that "rules" had been given by the use of letters. I asked him if he ever tried to find out what N stood for in a certain formula, and his reply was, "No," for he saw it was algebra and he knew he could not understand that. He was very much surprised when I read from the same page in explanation of the formula, "N equals the number of teeth in a gear and P the diametral pitch. Now, the number of teeth or N divided by the pitch or P, or $N \div P$, or $\frac{N}{P}$ equals the pitch diameter of the gear, or D, and expressed in its simplest form is

$$D = \frac{N}{P}$$

Who could ask for anything more explicit than that? Yet this man saw some letters in the book, thought it must be algebra, laid the book aside, and became resigned to his fate, knowing (?) that he could never master the subject as given in that book. I examined his note book and found there a number of rules on

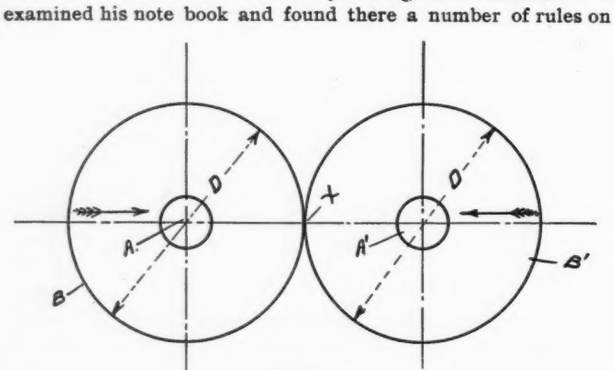


Fig. 1

the subject, given him by the foreman at different times, or when he had a job in which he needed assistance of this kind. These would work all right for certain problems, but when he had something a little different and needed but a slight change in rule, he was entirely at sea. Why? Because he did not know the fundamental principles upon which the rules were based.

This is a fault which many of us have; we will give a rule to cover the existing case without explaining the reasons for our different operations, thereby giving our friend a machine for special work, to be used for one kind of work and no other, when by spending a few moments (which would be well spent) and explaining the principle upon which we worked, we might open to him a field of which he never dreamed, and give into his hands a machine for general work with which he would be enabled to do different kinds of similar work. This is due a great many times to the fact that in this busy bustling world we have not the time to spare to stop and explain lengthy problems to our brother workman, and in a majority of shops we would not be allowed to use our employer's time for such work. Yet, would it not be for the manufacturer's benefit as well as the laborer's? Is not the amount, the quality and the class of work turned out in direct proportion to the intellectual knowledge which his employees possess? Would you not give your fellow workman the benefit of an evening's explanation of some subject, if he had interest enough to come to your home after working hours?

The object of this article is not to discuss our duty to our fellow man, but to explain in as clear and practical a manner possible the underlying principles of gearing, and give concise rules or

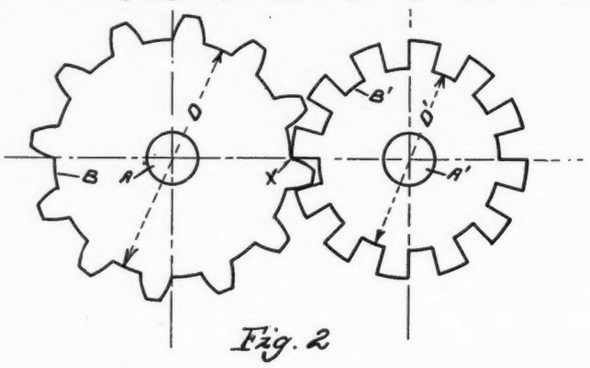


Fig. 2

formulæ (not algebra) for the solution of problems which arise in our everyday work upon gears.

PITCH DIAMETERS.

Two shafts A and A^1 (Fig. 1) carry rollers B and B^1. By having pressure on the shafts as indicated by the arrows, and revolving A, the friction of the rolls at the point of contact X will cause A^1 to revolve, but we can readily see that if any great amount of power is to be transmitted the rolls are liable to slip at the point of contact X, which will not give a positive motion; that is, it will require more than one revolution of the shaft A to produce one revolution of the shaft A^1.

Suppose as shown in Fig. 2 we put projections upon the surface of the roller B and cut recesses in the roller B^1, making them of such shape that the sides of the projections on roller B will slide with as little friction as possible upon the sides of the projections, caused by cutting the recesses in roller B^1. Then when shaft A is revolved, shaft A^1 must also revolve. The identity of the rollers B and B^1 is not lost, for we have simply added a number of projections to one and cut the same number of recesses in

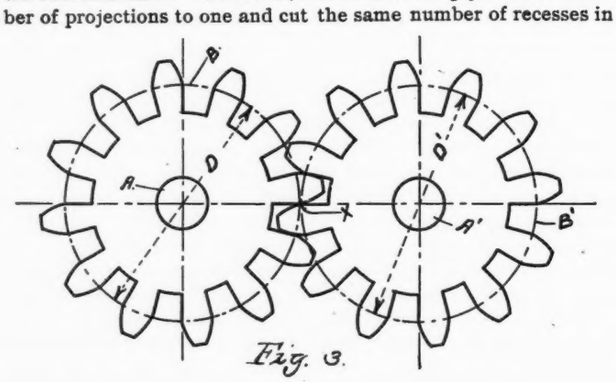


Fig. 3

the other, and the point of contact of the two rollers is still at X, but in this case there it no special pressure required to keep the rollers togethers as in the preceding case, nor is there any slip and consequently shaft A^1 will make one revolution in the same time that shaft A does.

In Fig. 3 we have changed Fig. 2 by adding projections between recesses in roller B^1 and on roller B cutting recesses between projections, and we have the regular gear tooth. We have now no visible part of the original rollers B and B^1 left, but

we have in their places imaginary rollers, the diameters of which are the pitch diameters of the gears. Thus we might have called our original rollers *pitch* rollers, and then proceeded to put on our projections and cut our recesses, which would have given us the gear wheel.

Of course in practice gears are never made in this way; the gear blank first being turned up to the correct diameter and then the space between the teeth cut out. The method of finding the outside diameter will be given later, this illustration being used simply to show the evolution of the gear wheel from the friction discs or pitch rollers.

PITCH.

When we speak of the pitch of a gear, the diametral pitch is generally referred to. The gear really has two pitches, diametral and circular.

The diametral pitch of a gear is the number of teeth for each inch of pitch diameter. If a gear has 20 teeth and the pitch diameter is 2 inches, the diametral pitch would equal $20 \div 2$, or 10, or there are 10 teeth in the gear for each inch of pitch diameter which it contains, and we would call it a 10-pitch gear.

The circular pitch of a gear is the distance from the center of one tooth to the center of the next adjacent tooth, measured on the pitch lines.

It is very seldom that circular pitch is used in describing cut gears, and I might say diametral pitch is invariably used. It seems to be the custom for foundry catalogs to give the circular pitch of cast gears. These seem to be the only places where circular pitch is used to any great extent, presumably from the fact that some of the patterns were made when circular pitch was used almost universally, and later patterns have been made to mesh with these.

* * *

THE NEXT article of the series on "Valve Gears," by E. T. Adams, will appear in August.

MR. H. M. NORRIS, late inspector of work at the Garvin Machine Company's shop, is now superintendent of the Bickford Drill & Tool Co., Cincinnati, Ohio.

* * *

PRACTICAL PATTERN MAKING.—2.

I. MCKIM CHASE.

EQUIPMENT OF A MODERN PATTERN-SHOP.

The most advantageous arrangement that can be given a modern pattern-shop depends upon the floor plan.

Assuming that the room is rectangular, of ample dimensions, and is sufficiently lighted on the sides, the most convenient disposition is to place the work benches along one side and the machines along the other. By this arrangement the dust and shavings can be kept under better control and the transmission of the power to the machines facilitated. Where the dimensions of the floor are about equal, lengthwise and across, and there is sufficient room for the benches along both sides, it is advisable to place the machines in the middle or at one end of the workshop. A room in which to keep the various articles used about the shop by the workmen, and belonging to the works, such as hand-screws, clamps and other tools, should be partitioned off. It should be the duty of the sweeper to see that these articles, when not in use, are kept in a place provided for them.

Stands or shelves should be erected at each lathe, and the various attachments—such as chucks, centers, etc., kept upon them when not being used. Similar fixtures should also be provided, where necessary, for the other machines.

The line shaft should run from 250 to 300 revolutions per minute. All wood-working machines require high speeds. With a moderately high speed to begin with, the necessary speed of the machines can be transmitted from the line shaft to better advantage than when a lower speed of the shaft prevails.

Wood-turning lathes are indispensable in a pattern-shop, and there should be several of them, their number depending on the number of workmen employed. In a shop having a force of forty pattern-makers, at least four lathes are necessary. One of these should be a face lathe for large diameters, ten feet or thereabouts. Another should be a combined face-and-tail stock lathe, having a face plate capable of swinging pieces of about six feet in diameter, and a capacity of two feet in diameter between the centers. The others should be ordinary wood-turning lathes of smaller capacity, one of which should be suitable for the smallest work. Wooden cones are preferable for wood-turning lathes, and they should be carefully balanced. The speed for wood-turning may vary from 1 200 to 2 500 feet per minute, according to the nature of the work.

In a shop of the foregoing capacity, two circular-saw machines are necessary, both of which should be provided with an iron table and an arrangement by which the vertical height of the saw may be adjusted. One of these should be capable of receiving a saw 28 inches in diameter, and the other a saw 14 inches in diameter. The smaller machines should combine both cross-cut and rip saws, and be so arranged that they can be made to "wabble" for rabbeting.

The usefulness of the machines depend largely on the condition in which they are kept. An excellent system is to have the teeth of circular saws shaped as in Fig. 5, and do all the filing on their front or cutting sides, the backs of the teeth being spiral curves. By this method, when the teeth are all filed equally on their fronts, the saw will be reduced uniformly in diameter, the amount of reduction depending on the spirality of the backs of the teeth and the extent of the filing.

To gum such a saw, a rotary or milling tool should be used. There are various neat little machines of this kind on the market, using mills of various sizes which can be clamped on the saw and the mill revolved by means of a crank, while it is fed to the tooth automatically. The mills make a rounded throat, which should extend slightly under the face of the teeth, so that in filing it will be unnecessary to extend the filing to the throat. This method requires but little filing to keep the saw sharp. If the saw is of sufficient size to admit of the employment of a swage for the setting of the teeth, this method should be adopted, as with it better results can be obtained from the saw than by bending the points of adjacent teeth in opposite directions. An excellent swaging tool is on the market with which the swaging is done by a cam operated with a lever. The style of tooth here commended is shown at Fig. 5.

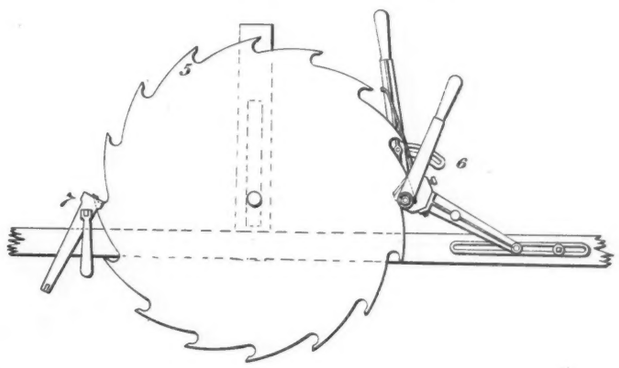


FIG. 5.

The bearings for the arbor of circular saws should be of ample length and babbitted. They require careful attention, and should be taken apart and cleaned periodically, as it is practically impossible to prevent dust working into them.

Circular saws give good results when running at speeds of from 8 000 to 10 000 feet per minute.

Circular saws are usually belted so that the revolutions of the arbor cannot be varied. In course of time saws become worn until their diameters are reduced considerably from their original dimensions; consequently there may be several saws of different diameters used on the same arbor, and of course their speeds will vary in proportion to their diameters. These conditions are met and the best results obtained from the machineby driving the arbor to the limit of speed for the largest diameter of saw to be used; that is, at about 10 000 feet per minute for the periphery of the teeth.

A handy device for use when dressing saws is shown in illustration 5. It consists of a T frame with the horizontal bar secured to a bench. The upright has a slot for the vertical adjustment of the saw. To the right is a swage, whose pivot can be adjusted on the horizontal bar; to the left is a small vise, 7, to receive one tooth of a saw. This vise is adjustable on the horizontal bar, to which it can be clamped by a thumb screw. By gluing a piece of paper around the end of the file and keeping it bearing on the shaft while filing, all the teeth can be filed alike without difficulty.

The next most important tool for a pattern-shop is the band

saw machine. In a shop of the before-mentioned capacity there should be, at least, two of these, one to carry saws up to 1½ inches wide, and the other to carry saws up to one inch. One great disadvantage in the use of these machines is the want of stiffness in the frames. There are but few made which are not deficient in this respect.

Bank-saws give good results when run at a speed of about 3500 feet per minute. These machines are usually provided with breaks for the stoppage of the saw, and should always be so arranged that a pressure on a pulley beyond a certain fixed limit cannot be produced by them. If they are not so provided, and the saw is stopped very suddenly, it is likely to break in consequence of the strain thus created. A great drawback to the use of these machines is the cost of the saws, which consequently break. That a band-saw will give way in the course of time is inevitable. Every time that a saw passes over the wheels while running, it bends and straightens again. This fatigues the material, and with continued running, it is distressed beyond ultimate endurance, just as any similar piece of metal would be broken by being bent back and forth a sufficient number of times.

The breakage of saws may be reduced by careful attention to their condition and that of the machine. In joining them they should be scarfed and lapped two teeth and brazed with silver solder. Immediately the tongs are removed from the joint, a few drops of oil should be dropped on the saw by the side of the lap. If not treated so, the saw is likely to become too soft on either side of the joint and will break there before any other part.

Band-saws should always be kept sharp and have a proper set to the teeth, and the wooden jaws on the guide bar of the ma-

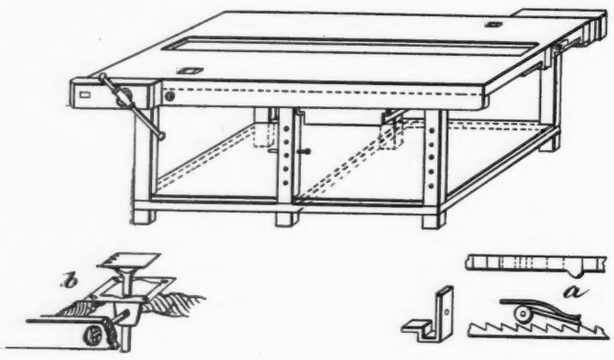


FIG. 6.

chine should be kept set up close to the saw. The mouth block in the table also requires frequent attention, as the deflection of the saws, especially the smaller ones, cuts them away.

An excellent little machine for sharpening and setting band-saws is to be found on the market. It can be secured to a post, and occupies little room. Being driven by power, a saw can be put in, the machine set going and allowed to run without further attention until the saw is finished.

Another important machine in the pattern-shop is a hand-planer or joiner. There should be two of these machines, one with 16-inch knives, to be kept for rough work; the other with 24-inch knives, to be reserved exclusively for the cleaner and finer class of work, because, if allowed to be used indiscriminately, the latter will seldom be in the condition essential for the kind of work required of it and for which the machine is specially adapted. The back table of a hand-planer should be provided with a locking arrange ment, in order that its position cannot be changed after having been adjusted to the knives.

The speed recommended for hand-planers is 4 000 feet per minute, but they will work satisfactorily between that speed and 35 000.

A surface or cylinder planer is also a useful machine in a pattern-shop. An improved machine of this kind does not require a great amount of attention; it suffices to have the knives kept in proper condition and the bearings inspected occasionally, to see that the oil is properly performing its functions.

The speed is the same as for the hand-planer. When it is difficult to obtain 4 000 feet per minute, a speed between that and 3 500 feet will give satisfaction.

A Daniel's planer is very useful in a pattern shop. These are simple, effective and durable, requiring but little instruction regarding their care and use. With this planer the lumber can be planed out of wind, which cannot be done with a cylinder planer, although the work is not so rapidly done as with the latter.

The cutters of a Daniel's planer should run at a high rate of speed, say from 10 000 to 11 000 feet per minute.

A jig-saw is required in a pattern-shop for inside sawing. The band-saw, which has supplanted it for outside sawing, is not adapted for positions bounded entirely by the material.

An advisable speed for this machine is from 500 to 1 000 strokes per minutes, according to the character of the machine.

A vertical boring machine is also useful in a pattern shop. One having a capacity for boring holes up to two inches in diameter is preferable, and should be arranged with two speeds, one to produce 850 or 900 revolutions of spindle for bits more than 1¼ inches in diameter; the other 1 200 or 1 300 revolutions for smaller bits.

Among the minor power machines that a pattern shop should have, are—a grinder for planer knives, a wet emery grinder for bench tools, and two grindstones, one of the latter being corrugated for the convenience of grinding inside bevel gouges.

Trimmers are indispensable in a modern pattern shop. It is advisable to have at least two of the largest size for the general use of the shop, and several of smaller size, one being located convenient to each two benches.

There are several other necessary adjuncts to the complete equipment of a pattern shop, but these are so well known that description of them is here unnecessary.

The bearings of wood-working machinery require very careful attention, in consequence of the high speed at which it revolves and their liability to the deteriorating effects of dust. Bearings should always be provided with tallow boxes which should be kept filled with tallow, or, better, with Albany grease. A small hole should be made through the grease near each end of the bearing, into which a little oil should be dropped before starting the machine; then, should the oil work off with continuous running, the grease will continue to keep the bearing lubricated.

The foregoing is noted as to machines necessary for the equipment of an up-to-date pattern shop, one that should be able to perform with precision, expedition and economy, as far as facilities are concerned, the work required of it.

Of course, it is possible to get along, in a manner, with less machinery, but such a shop would be at a disadvantage when competing with a better equipped concern.

In many shops a great variety of wood-work is done other than that of pattern making. In such establishments additional machinery is necessary, the kind and quantity of which will be governed by the nature and extent of the work.

The style of work bench usually furnished pattern makers is the ordinary carpenter's bench, 16 feet long. Pattern makers seldom have need of a bench more than 12 feet long, and illustration III. represents a convenient style.

The dimensions of a double bench of this kind, well adapted for pattern work, are—12 feet long, 4 feet wide and 3 feet high. For a single bench the width should be 3 feet, and the other dimensions the same as for a double bench. Each bench should have a shelf about 1 foot from the floor, extending over the entire space between the legs of the bench. It should also have a drawer for each workman. The framing and the top should be of hard wood about 3 inches thick, except for about 18 inches in the middle of the width of the top; this can be of 1-inch pine placed flush with the bottom of the side pieces, forming a recess in the middle of the bench, as illustrated. This recess is convenient for the retention of small tools and articles to be used about the bench. The jaw of the vise is placed horizontally, and to it is attached a ratchet bar sliding in bearings under the end of the bench. A pawl is fitted into the bench over the bar by means of which the jaw can be adjusted to suit the work to be clamped. This device is shown in detail, marked *a*. The vise screw is of iron, which works more easily than if made of wood. The above arrangement of the vise is more convenient than the ordinary vertical position, as this necessitates stooping on the part of the workman in order to attend to the adjustment; and rather than do this he will often use the vise in an awkward position, to the risk of resulting damage.

When sufficient space is available, single benches are preferable. With double benches, the space necessary per workman in the length of the bench row is about 5½ feet; with single benches it is about 6½ feet.

HOW TO CALCULATE, DESIGN AND CONSTRUCT ELECTRICAL MACHINERY.—2.

Wm. Baxter, Jr.

If a wire, such as is shown at A in Fig. 8, is moved across the lines of force passing between the north and the south poles of a magnet, an electro motive force will be developed in it. An electro motive force is that force that tends to set an electric current in motion, and which will do so if the resistance opposed to the current is not infinite. If the motion of the wire is in the direction indicated by the arrow B, the direction in which the current would flow in the wire if the two ends were joined, would be towards the reader, as indicated by the arrow. If after the wire has been moved to the opposite side of the field it is returned, there will be developed an electro motive force, which will be in the opposite direction to the first one. Thus it will be seen that if the field remains unchanged in direction, the electro motive force will be in a direction dependent upon the direction in which the wire is moved. So far as the action of the field upon the wire is concerned, it makes no difference whether the ends are joined, so as to form a closed circuit, or not; but if the ends are not joined, there will be no flow of current, as electricity will not flow except in an endless path. With a straight bar as shown at A in the figure, there would be developed an electro motive force or electric pressure, as it is sometimes called, which would tend to set a current in motion, but here the action would end. The power required to move the wire across the lines of force would be no more than that necessary to overcome

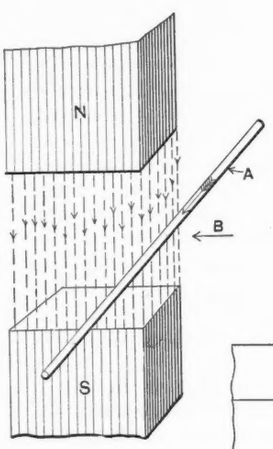


Fig. 8

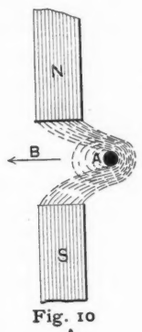


Fig. 10

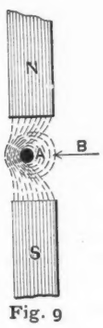


Fig. 9

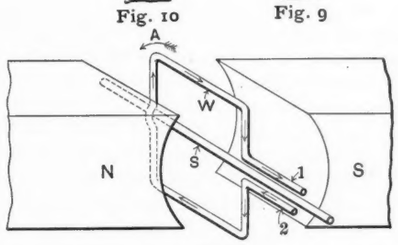


Fig. 11

the resistance of the atmosphere, if the straight rod A were used, but if its ends were connected, so that a current could circulate a greater amount of power would be required. If the wire connecting the ends of rod A were very fine, the power would be less than if it were very thick. The reason for this difference would be that with the fine wire the current that would circulate would be much smaller than with the large wire. From these facts we can learn two things, one that to develope an electro motive force alone requires no power; the other, that to generate a current does require power, and that the greater the current the greater the power. This is as it should be, since electro motive force is not of itself a form of energy, any more than is pressure of any kind. When a current begins to move, then energy is developed, just as in the case of water or steam. The measure of the power is the amount of current multiplied by the electro motive force, just as in steam it is the number of cubic feet multiplied by the pressure. The units by which exact measurements are made will be explained hereafter.

Since the movement of a wire across the lines of force passing from one pole to the other will generate a current if the ends of the wire are joined, it is self-evident that if there is already a current flowing in the wire in the same direction in which the movement would cause it to flow, the effect will be that this current will be increased, but this increase will be obtained by the expenditure of power, just as would be the case if there were no current flowing in the wire, and the amount of power would be in strict proportion to the increase in current. If the wire has a current flowing in it in the opposite direction to that induced by the movement across the field, the effect will be to reduce the current, and therefore instead of power being required to effect the movement, power will be developed by it; that is, the wire will move across the field of its own accord, and to prevent it from so doing it will be necessary to apply a retarding force.

The first of the two cases just cited represents in the most elementary form a generator of electricity, or dynamo; the second is an electric motor. The first absorbs power from an external source and generates a current; the second absorbs current from an external source and developes power. The elementary principles involved in both actions can be better explained by the aid of Figs. 9 and 10.

Fig. 9 illustrates the principle of action of a generator, Fig. 10 that of a motor. From the relation between the direction of the current and the lines of force surrounding it, it will be seen that in Fig. 9 as the current is coming towards the observer, as shown in Fig. 8, the lines around the wire will be in the same direction on the left hand side as those of the magnet; now as the lines of the field resist passing over to the side where they will be resisted by those of the wire, they will not do so until forced to it by a sufficient amount of stretching; hence, the movement of the wire is resisted. The stronger the current flowing in the wire the greater the resistance, because the number of lines surrounding the wire increases with the current, and the greater the field around the wire the greater the resistance of the magnet field to being moved to a position where it must oppose it.

In the case of the motor shown in Fig. 10, the current is reversed, and hence the direction of the lines of force around it is reversed. This being the case, the lines of the field magnet correspond in direction with the right hand side of the field around the wire, and are opposed to this field on its left hand side. On this account the field lines pass over to the right side of the wire, and by their contracting tendency draw the wire over in the direction indicated by the arrow B.

If the wire A in Fig. 8 were placed in the center of the space between the pole pieces N S, and a current of electricity were sent through it, the result would be that it would at once move out of the space, to one side or the other, according to the direction of the current, but it would remain in place if not traversed by a current. The explanation of this action is that if the wire remained in its position the lines of force around it would on one side run with those of the field, and on the other would run against them, and this latter action would be resisted, because it is contrary to the natural order of things.

If instead of a single wire we use a loop as shown in Fig. 11 and fasten it to a shaft so that it may be revolved thereby, the effect will be that twice the electro motive force will be developed with the same strength of field. If the loop is revolved in the direction indicated by the arrow, the current generated in the upper side will be toward the front, and in the lower side toward the back, since the motion of both sides through the lines of force will be in opposite directions. The direction of the two currents will be opposite in relation to any point in space, but will be in the same direction through the wire, as can be readily seen from the figure. If we consider what takes place in the course of a whole revolution, we will find that during the first half, the flow of current in the wire will be in one direction, and during the next half it will be in the opposite direction. Suppose we start with the side W on top, then while this is rotated through the N side of the field to the under side, the current generated in it will be in the same direction, and this will be true of the current generated in the opposite side of the loop, which will be moving up in front of the S pole of the magnet. When the second half of the revolution commences, the W side of the loop will pass up in front of the S pole, and, therefore, will have a current generated in it that will be directed toward the rear, and this will be opposite in direction to what it was during the first half revolution. Hence, during the first half of the revolution the current runs in one direction and during the second half it runs in the opposite direction. What effect this has upon the action of motors and generators can be seen from the explanations of Figs. 12 to 17.

Figs. 12, 13 and 14 illustrate the action of an electric motor. The first figure shows the change in the position of the lines of

force of the field occasioned by the passage of a current through the loop L, which takes the place of that shown in Fig. 11. Before the current passes through this loop, the lines of force will run straight from one pole to the other, as shown in Fig. 14, but the instant the current is turned on, they will be diverted from their natural path, and will exert a pull on the sides A and B of the loop L that will cause it to rotate in the direction indicated by the arrow. At first the pull will not be very great, because the lines of the field will not be able to act in a direction that is very effective, but by the time the loop has been rotated to the position shown in Fig. 13, the full force of the field will be exerted upon it. From this point forward the rotative force will gradually decrease, and when the half revolution has been completed,

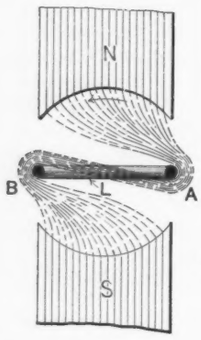


Fig. 12

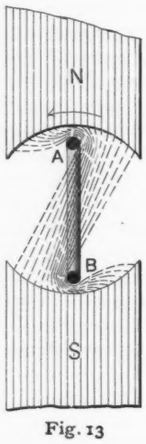


Fig. 13

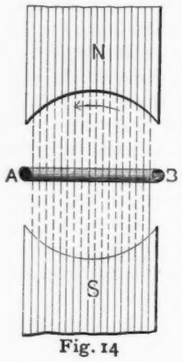


Fig. 14

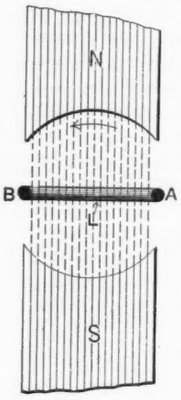


Fig. 15

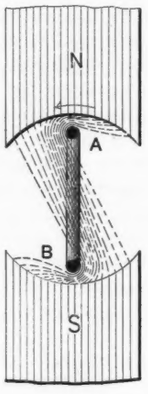


Fig. 16

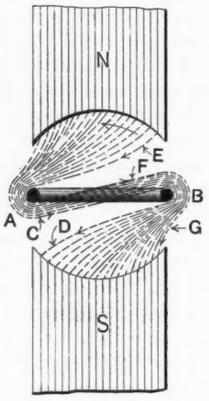


Fig. 17

it will be reduced to nothing, as then the lines of force of the field will be running in straight lines as shown in Fig. 14. When this point is reached there will be no further tendency to rotate the loop in either direction, and if it is desired to continue the rotation, the direction of the current through the wire must be reversed. This reversal of the current will restore the same conditions that existed in Fig. 12, for now the side B of the loop will be in the same position as A was, and the effect of reversing the current will be to give it the same direction in side B as it had in side A, Fig. 12. From this it will be seen that to maintain a continuous pull all the way around the circle, it is necessary to reverse the direction of the current through the wire at each half revolution. This result is accomplished by means of a device called a commutator, which will be explained further on.

Fig. 15 shows the relation of the loop L and the lines of force of the field in a generator at a point where the developement of an electro motive force commences. If the loop is rotated in the

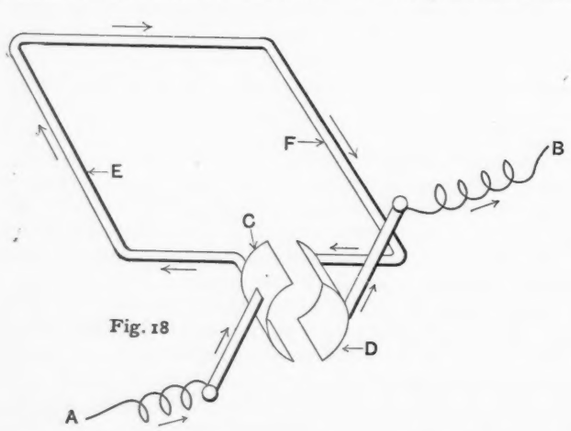


Fig. 18

direction indicated by the arrow, a current will begin to flow, and for the reasons already explained, the wire will carry the lines ahead of it, as shown in Figs. 16 and 17. In Fig. 16 the resistance offered by the lines to the movement of the wire will be the greatest, and therefore the current generated will be the strongest. From this point to the end of the half revolution the resistance opposed to the rotation of the wire will reduce, and as a consequence the strength of the current will be less, and will become zero at the end of the half revolution. If the rotation is continued, a current will be generated in the second half revolution, but its direction through the wire will be opposite to that developed during the first half. Why the direction of current should be reversed in the second half revolution can be easily understood from an examination of Fig. 17, where it will be seen that the lines at C around the side A of the loop, run in opposition to the lines at D, coming from the S pole. The same conditions exist at E and F on the B side of loop. Now as the lines cannot run in opposite directions in the same space, the C D lines break away from side B and the E F lines from side A; hence all the lines around A cut through to the right of the loop, and all the lines around B cut through to the left, and the conditions of Fig. 15 are restored; hence the further rotation of the loop will cause a current to flow inside B in the same direction as it did in side A in Fig. 15. If it is desired that the current in the wire outside of the loop L be always in the same direction, it will be necessary to make use of the commutator.

From these explanations we can see that if a motor is supplied with a current that flows always in the same direction, continuous rotation cannot be obtained unless the current through the loop L is reversed at each half revolution, because there would be a pull exerted only through one-half of each turn, and during the other half the machine would act as a generator, and would absorb as much power as it gave off in the first half turn, that is, the resistance to motion in the second half would be equal to the pull in the first half.

With the generator it makes no difference whether the loop L is going through the first or the second half of the revolution; in both cases a current is generated, but the direction is changed at each half revolution, and if we desire to have a current running continuously in the same direction we must use a commutator.

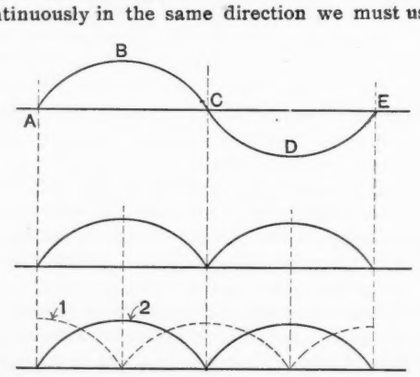


FIG. 19.

FIG. 20.

FIG. 21.

If we were to supply the motor with a current that changed its direction, we would obtain continuous rotation without using a commutator, as the only office of the latter device is to reverse the direction of the current through the loop L. Currents that run alternately in opposite directions are called alternating currents and are used very extensively, and with these a motor constructed upon the principle here explained would run without a commutator, providing the field magnets were energized by a continuous current, so as to always maintain the same polarity. If the alternating current went through the field magnet coils, a commutator would be required.

Fig. 18 illustrates a commutator in its most simple form. An examination of it will show that if the current coming through the wire A does not change its direction, it will flow through the

loop from C to D in the direction indicated by the arrows, so long as A is in contact with C and B with D; but as the loop revolves and A and B do not, at each half revolution the relations between A B C D will change. When A comes in contact with D and B with C, the direction of the current through the loop will be reversed.

In regular machines the commutator is not made in as simple a manner as shown in this figure, but the principle of action is the same. One of the reasons why this simplicity is departed from can be made clear from the following:

In the case of the generator, as explained in the preceding paragraph, the current not only changes its direction at each half revolution, but during each half its strength rises from nothing to a maximum amount and then drops to zero again. This growth of the current can be shown graphically by means of a curve such as Fig. 19, in which the distance from the straight line A C E to the curve, represents the strength of the current at any point in the revolution, A being the commencement of the revolution, C the half turn, and E the complete turn. At A the current is zero, and from here it gradually grows in strength to a point midway between A and C, where it reaches its maximum strength, as indicated at B. From this point to C it again reduces, becoming zero at C. From here it begins to grow, running in the opposite direction, and therefore is shown under the line. At D it attains its maximum strength in the opposite direction, and then reduces to zero again at the point E.

If a commutator is provided that will reverse the direction of the current at each half revolution, its only effect will be to change the curve of Fig. 19 to that shown in Fig. 20, but the current will not be uniform, and if the machine is a motor the pull will not be equal all the way around the circle. The current in the case of a generator, and the pull in the case of a motor, will pulsate between the maximum amount and nothing. Now it is evident that if instead of only having one loop as shown in Figs 12 to 17, we had two, set at right angles to each other, and each one provided with its own commutator, the pull of the motor and the current of the generator would become more even, because one loop would be doing its greatest work at the time when the other one would be doing nothing. The equalizing effect of two loops set at right angles is illustrated in Fig. 21, in which the curves 1 and 2 represent the effect due to each loop.

For reasons that will be explained at the proper time, the number of loops in regular machines is always much greater than two, but this number would answer every purpose if the only object were to equalize the current or the pull.

From what has been said so far it will be seen that the principles upon which electrical machinery acts are very simple, but the mere understanding of these principles would not enable us to design machinery with any degree of certainty as to the results that would be obtained from it. In order to be able to design a motor or a generator of a certain capacity, we must know the exact relation between the lines of force in the field and the electro-motive force developed in the loops and between the lines of force, and the current required to develope them, etc., etc. These relations are well understood, and they will be fully explained in the next article.

* * *

HORSE POWER AND THE POWER OF A HORSE.

One gets a fair—at least a comprehensive—idea of the enormous power concentrated in some of the modern liners by comparison with something he is familiar with. Some of these have engines capable of developing 25 000 horse power, which would be a pretty large aggregation of horses. They would be represented by a weight of, perhaps, 25 000 000 pounds, which is considerable horse flesh. But 25 000 horses could not do the work. Watt concluded, with the sagacity with which he came to a good many other conclusions in relation to the steam engine, that a horse engaged in freeing the mines of water could lift 33 000 pounds one foot high in a minute of time, and that was the unit by which he measured his engines which took the place of the horses, and so the conventional "horse power" came about. But for all this there is a good deal of difference between a horse power and the power of a horse. The steam engine will, for each horse power, lift 33 000 pounds one foot high each minute of the 24 hours of the day. It is a good horse that can do it day by day for eight of the 24 hours. If the arrangement could be such that the power of the horses exerted on shore could be utilized in propelling one of these steamships from New York to Liverpool, 75 000 instead of 25 000 horses would be required for the purpose, and the "motive power" would weigh 75 000 000 pounds. It *would* be quite an army of horses, to be sure. The engines of a steamship developing the power named would require the consumption, let us say, of 450 tons of coal per day. The weight of the fuel (oats and hay) consumed by the horses per day may be taken at, say, 3 000 000 pounds. Assume the coal to cost, say, four dollars per ton, in the furnaces. That is $1 800 per day for fuel. The feed and care of a horse engaged in such work may be taken at fifty cents per day, or $37 500 in favor of steam, and the figures are made to favor the horses rather than otherwise.

Take a more generally familiar example. Let it be that of an engine on shore doing 100 horse power of work for ten hours per day. Say the coal burned is 1½ tons, and that this is worth, in the furnace, $7.50. There would be required to do this work 125 horses, and the cost of feed for them would be $62.50, against $7.50 for steam, and again the figures are made to favor the horses. We never know what the steam engine is doing for the world till we take a little time to "cast up accounts."

F. F. H.

* * *

MECHANISM FOR MECHANICS.—5.

PROF. CHAS. H. BENJAMIN.

DEFINITIONS.

The circles A A and *a a*, which limit the faces of the teeth, are called *addendum circles*, and the circles R R and *r r*, which limit the flanks, are called *root circles*. See Fig. 15, June issue.

Clearance is the space between the addendum circle of one wheel and the root circle of the other, measured on the line of centers, and is usually about $\frac{1}{16}$ the height of the tooth.

Backlash is the difference between the width of a tooth and the width of a space measured on the pitch circle.

Path of contact is the total length of the path $P \times P^1$ from the beginning until the end of contact of one pair of teeth, measured on the two describing circles. It is equal to the sum of the arcs of approach and recess, and must be greater than the pitch.

Circular pitch is the distance from the center of one tooth to the center of the next measured on the pitch circle, and is equal to the circumference of the pitch circle divided by the number of teeth, and of course includes a tooth and a space.

Diametral pitch is a dimension obtained by dividing the diameter of the pitch circle by the number of teeth, and is equal to the circular pitch divided by 3.1416.

Pitch number is the reciprocal of the diametral pitch and may be obtained by dividing the number of teeth by the diameter of the pitch circle in inches. Pitch number means the number of teeth per inch of diameter, and furnishes the handiest method of classing gears according to size of teeth. For example, suppose that a gear has 48 teeth and that the diameter of the pitch circle is 16 inches.

The circumference will be $16 \times 3.1416 = 50.26$ inches and the circular pitch $\frac{50.26}{48} = 1.048$ inches.

The diametral pitch $= \frac{48}{16} = 3$ inches.

The pitch number $= \frac{48}{16} = 3$ inches.

This gear would accordingly be called a 3 pitch gear or one having three teeth per inch of diameter.

Notice that when we speak of the circumference or diameter of a gear we always mean the pitch circle.

The following table gives the dimensions of gear teeth as ordinarily made in this country:

PROPORTIONS OF GEAR TEETH.

Kind of tooth.	Face.	Flank.	Clearance.	Height.
Machine Cut	d	1¼d	⅛d	2⅛d
Machine Moulded	.32p	.38p	.06p	.7p
Pattern Moulded	.32p	.38p	.06p	.7p
Short Tooth	.28p	.27p	.04p	.5p

d means diametral pitch, *c* circular pitch. The only difference between the machine moulded and pattern moulded teeth in proportions is that the former may have less backlash than the latter, the amount varying from .04p to .06p.

DIAMETER OF DESCRIBING CIRCLE.

From Fig. 15 (last issue) it may be seen that it is necessary that the circle which is used to describe the faces of one gear must also be used for the flanks of the other. Now if it is desired to make a set of gears so that any one of the set may gear with any

other, it is necessary that the same describing circle be used for all the faces and flanks.

It is a property of the hypocycloid that if the describing circle is just half as large as the circle inside which it rolls, the curve will become a straight line coinciding with the diameter of the outer circle, and the teeth thus described will have radial flanks. See *b*, Fig. 16. If the rolling circle be made still larger the flanks will curve under and the tooth will be weak at the root. See *c*, Fig. 16.

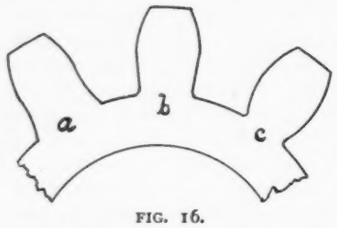


FIG. 16.

Pinions of less than 15 teeth are rarely used. If the pinion of 15 teeth is then assumed to be the smallest wheel in the set, the teeth of that pinion may be assumed to be radial, and the diameter of the describing circle for the set may be taken one-half the diameter of the pinion.

For example, if we are to design a set of 4 pitch wheels, the diameter of the pinion of 15 teeth will be $\frac{15}{4} = 3\frac{3}{4}$ inches, and therefore we would use a describing circle having a diameter of $1\frac{7}{8}$ inches for all the wheels of that set.

HOW TO DRAW CYCLOIDS.

The method of drawing cycloids here given is the one best adapted to the construction of gear teeth when only a short portion of the curve is needed. In Fig. 17 let C be the center of the pitch circle Q Q and let A A be the addendum circle limiting the faces of the teeth. Let E be the center of the describing circle. On the describing circle lay off an arc X P, such that P comes outside the circle A A. Lay off an equal arc X K on the pitch circle. Divide each of these arcs into the same number of equal parts, as 1, 2, 3; I., II., III., etc. With a radius equal X L (the chord of the arc) and a center at the point 1 describe a short arc from X outward. With a radius = X II. and center at 2 draw another short arc outward from the first arc. Continue the process as shown, each arc just touching the one before it. A curve tangent to the outside of these arcs will be the epicycloid. A hypocycloid for the flank of the same tooth may be drawn by rising the circle N C in the same manner. The faces and flanks of a rack tooth are just alike, being cycloids, and may be drawn in a similar manner by rolling the describing circle on a straight line.

In practice the most convenient method of drawing teeth is to make a template by inserting a long strip of thin wood under the drawing and pricking through the paper with a needle point the outline of the tooth *b* X *a*, and also locating the center C on the template. This template may then be cut out and used in drawing the rest of the teeth. In constructing patterns, the paper containing the outline of the tooth may be cemented to a thin strip of metal and the metal carefully filed to the outline and used for a template directly on the pattern. The greatest care and accuracy are required in these constructions to give good results.

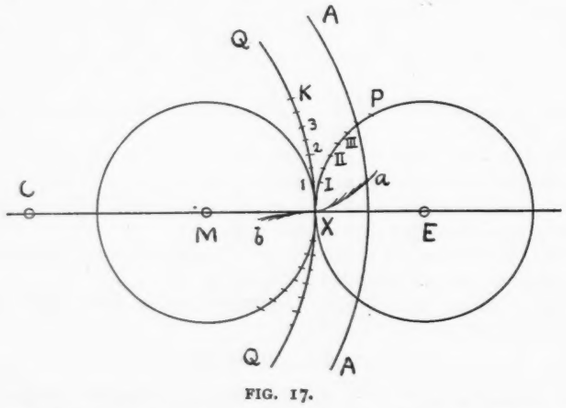


FIG. 17.

METHODS OF LAYING OFF EQUAL ARCS.

Approximately equal distances may be laid off on two unequal circles by spacing, but more convenient methods are those known as Rankine's. These are given in all works on mechanism, but will be repeated here for convenience.

1. To lay off a given arc on a tangent at one extremity of the arc.

In Fig. 18 let A B be the given arc and A T the tangent at A. Draw the straight line B A and produce it to C, making A C = ½ B A. With C as a center and C B as radius describe an arc B D cutting A T at D. Then will the straight line A D be approximately equal to the arc A B.

2. To lay off a given straight line on an arc to which it is tangent.

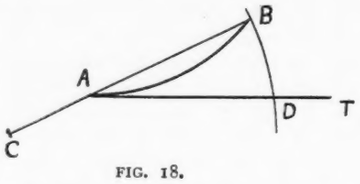


FIG. 18.

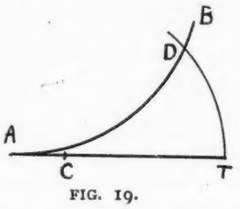


FIG. 19.

In Fig. 19 let A T be the given line tangent to the arc A B at A. Lay off on the line A C = ¼ A T. Then with C as a center and C T as radius describe the arc T D cutting A B at D. Then will the arc A D be closely equal to line A T.

These methods are only approximate, but if the arc be not more than 60° the error is only about $\frac{1}{900}$ of the length of the arc.

* * *

METAL PATTERNS.

WARREN E. WILLIS.

While metal patterns are necessarily expensive, their cost is warranted, and in fact made obligatory on many articles which are to be produced in quantities, especially if the sections are thin, or the shape such that a wooden pattern would become warped or otherwise distorted from its original shape.

A careful consideration should be paid to these possibilities before the work goes into the pattern makers' hands and the decision arrived at as to whether it is desirable to have metal patterns or if wooden ones will meet the requirements.

Too frequently a change of opinion occurs and one of the casts from the wood is taken as the nucleus for the metal pattern.

Sometimes—but not often—this method is satisfactory; usually the double shrink, added to the amount of metal necessarily removed in finishing up the pattern, renders it unfit for use altogether and the expense of new patterns becomes necessary, or that of building up on the metal must be incurred.

Again where sharp corners are encountered, the casting has the disagreeable habit of frequently shrinking so as to present an overhanging edge, which when removed so as to give proper draft makes the said edge too thin. Take for example cases and covers for gears and other thin box like castings. If ones' foresight only equalled their hind-sight of course these things would not occur. For small articles that can be gated or cast on a mould board, metal patterns are almost invariably to be preferred.

An unaccountable prejudice against anything but cast iron pattern exists in an iron foundry, while the brass founder is equally strong in favor of brass. The softer, so-called white metals are used to a limited extent although they seem to possess some desirable advantages; that of being more easily prepared and also susceptible to a moderate change in shape with greater ease than other metals.

In getting out the cases for a cash register, the writer once had opportunity to experimentally discover some points, that are probably not new to those in the trade, in the line of thin ornamental work, but certainly are not common.

The work was begun with orders to produce something highly ornamental, artistic and at the same time practical. It was decided that the finish might be polish, dip, oxidize or plate; of course it was out of the question to expect to finish by polishing the entire surface, including the ground work, or to get a casting from any practical method of founding that would be sufficiently smooth, so a roughened mat surface composed of what might be called "regular irregularities" was decided upon.

Lincrusta Walton and other embossed ready made fabrics were thought to be too common and beside the pattern obtainable did not seem to conform or harmonize as was desired.

Finally blue prints were made, the size and shape of the various parts, sides, front, back, drawer, etc., and arrangements effected whereby a prominent school of design was induced to offer prizes for a competitive original design amongst the advanced pupils. The chief designer of a well known silver goods manufacturing house, a competent register man and the

principal of the school, acted as committee, on the score or more of designs submitted. It may be reasonably presumed that something quite satisfactory was produced, so far as design went, but there still remained the transposing of these graceful figures into hard metal.

Several prints were made of each part, from tracings taken from the originals; one of these was affixed to the face of a thin sheet of wood that formed the foundation, that being in turn secured to the mould board, while over the entire surface of this blue print was placed one layer of "bobinet." This fabric is woven in such a manner that regular polygonal openings or interstices, about one sixteenth of an inch in diameter are formed, while the thickness of the body, which has considerable "staying" qualities, is about two one-hundredths of an inch.

This formed the background of "regular irregularities," while through the the openings in the bobinet could be seen the figures, on the underlying blue print, sufficiently well to place in their proper location, pieces of card board of the desired thickness previously cut to the outlines of duplicate prints pasted on its surface. It will be understood that in cutting the cardboard the knife was carried at an angle so as to allow for draft, and that a minature wax fillet ran around the entire outline.

ESTIMATING COST OF POWER AND POWER PLANTS.

In looking over my notes and tables the other day I came across a table compiled by one of the engineers of a leading electrical manufacturing company, and presumably one that has been used by this company for making estimates on new plants. It is quite comprehensive as it includes all the varieties of engines likely to be met, the electrical end of the combination being assumed at an average attainable efficiency.

By "short stroke" is evidently meant high speed engines, the slower running Corliss or Greene types being designated as "long stroke." This represents more work than one is apt to realize unless he has compiled similar data, and while not assumed to be the exact figures that would be obtained under all conditions, gives a basis to guess from, as the Editor said regarding the data concerning "forcing fits."

R. E. MARKS.

* * *

OBSERVING DETAILS.

It seems to me that many men loose numerous advantages as well as pleasures in life, by lack of observation and thought, and a failure to profit by the experience of others. For reasons too obvious to mention, no names will be given in the following incident, but there seems to be a lesson in it.

Among other things the superintendent of a certain shop called my attention to a large radial drill by saying: "You see the mechanism is all driven from that vertical shaft running up through the column and connected to the countershaft by bevel gears, which looks all very well on paper or at first glance; but you ought to run it a while. It is about twelve feet from the floor to those gears, and swinging that arm around the column causes enough vibration in it to affect their smooth running—it don't take much. They are held pretty securely in place by their connections, and a heavy piece of work will cramp that shaft beyond all reasonable allowance, although the floor is about as stiff as wood can make it. Even the expansion and contraction of the floor is enough to cause some trouble. There is an excessive strain on those bearings nearly all the time, caused by the cramping of that shaft due to the vibrations, showing between those bevel gears and the top of that column. Give me a good belt connection between the machine and the shafting every time. When we got that tool it was the best I could get the manager to buy, and now I wish he hadn't got any, for it is a new tool, and he expects just as much from it as if it was the best." G.

COMPARATIVE TABLE OF HORSE POWER — FUEL CONSUMPTION — WATER CONSUMPTION — COST &c. FOR ONE 1000 H.P. POWER PLANT FOR ELECTRIC R.R.

		Single Cylinder Short Stroke Non Condensing Engines	Single Cylinder Long Stroke Non Condensing Engines	Single Cylinder Short Stroke Condensing Engines	Single Cylinder Long Stroke Condensing Engines	Compound Short Stroke Non Condensing Engines	Compound Long Stroke Non Condensing Engines	Compound Short Stroke Condensing Engines	Compound Long Stroke Condensing Engines	Triple Expansion Short Stroke Condensing Engines	Triple Expansion Long Stroke Condensing Engines
Consumption of Dry Steam per H.P. per hour	Theoretical	20-27 lbs.	20-27 lbs.	18-19-lbs	18-19-lbs	18-25-lbs	18-25-lbs	12-16-lbs	12-16 lbs	9-11 lbs	9-11-lbs
Consumption of Dry Steam per H.P. per hour	Practical	30 lbs.	30-lbs.	20-lbs	20 lbs.	25-lbs.	25 lbs.	16-lbs.	16-lbs	13-lbs	13-lbs
Consumption of Dry Steam per 1000 HP per hour	"	30000 lbs	30000-lbs	20,000-lbs	20,000 lbs	25,000-lbs	25,000-lbs	16,000-lbs	16,000-lbs	13,000-lbs	13,000-lbs
Consumption of Water per day of 18 hours	"	64,800 Gal.	64,800 Gal	43,200 Gal	43,200 Gal.	54,000 Gal	54,000 Gal	34,500 Gal	34,500 Gal	28,000 Gal.	28,000 Gal
Consumption of Water per year of 365 days.	"	23,000,000 "	23,000,000 "	15,700,000 "	15,700,000 "	20,700,000 "	20,700,000 "	12,600,000 "	12,600,000 "	10,220,000 "	10,220,000 "
Cost of Feed Water per year @ 10¢ per 1000 Gal.		$ 2,300	$ 2,300	$ 1,570	$ 1,570	$ 2,070	$ 2,070	$ 1,260	$ 1,260	$ 1,022	$ 1,022
Consumption of Combustible per H.P. per hour.	"	3.75-lbs	3.75-lbs	2.5-lbs	2.5 lbs	2.5-lbs	2.5-lbs	1.6-lbs	1.6-lbs	1.3-lbs	1.3-lbs
Consumption of Combustible per 1000 HP per hour	"	1.875 tons	1.875 tons	1.250 tons	1,250 tons	1.250 tons	1.250 tons	.8 tons.	.8 tons	.65 tons	65 tons
Consumption of Combustible per day of 18 hours	"	3375 "	3375 "	22.50 "	22.50 "	22.50 "	22.50 "	14.40 "	14.40 "	11.70 "	11.70 "
Consumption of Combustible per year of 365 days	"	12318 "	12318 "	8212 "	8212 "	8212 "	8,212 "	5256 "	5256 "	4270 "	4270
Cost of Combustible per year @ $4.00 per ton		$ 49,272	$ 49,272	$ 32,848	$ 32,848	$ 32,848	$ 32,848	$ 21,024	$ 21,024	$ 17,080	$ 17,080
Boiler pressure in lbs. per square inch	"	60-100	60-100	75-100	75-100	90-110	90-110	90-130	90-130	125-180	125-180
Style of Boilers R.T. = Return Tubular		R.T.	R.T.	R.T.	R.T.	Water Tube	Water Tube	W.T	W.T.	W.T.	W.T.
Square feet of heating surface to the H.P.		15	15	15	15	12	12	12	12	12	12
Evaporating capacity per sq. foot of heating surface	Per hour	2½-lbs.	2½-lbs	2½ lbs	2½ lbs	3-lbs.	3-lbs	3-lbs.	3-lbs	3-lbs.	3-lbs.
Boiler H.P. required for Plant	Theoretical	1000	1000	700	700	800	800	475	475	360	360
Boiler H.P. required for Plant.	Practical	1100	1100	875	875	900	900	650	650	560	560
Proportion of Boiler Power to Engine Power	Theoretical	100%	100%	70%	70%	80%	80%	47.5%	47.5%	36%	36%
Proportion of Boiler Power to Engine Power	Practical	110%	110%	87.5%	87.5%	90%	90%	65%	65%	56%	56%
Proportion of Engine Cylinders	"					1 to 3-4	1 to 3-4	1 to 3-4	1 to 3-4	1-2¾-5	1-2¾-5
Average piston speed in Feet per minute	"	600	600	600	600	600	600	600	600	600	600
Variation in Speed from no load to full load.		1-2%	4-6%	1-2%	4-6%	1-2%	4-6%	1-2%	4-6%	1-2%	4-6%
Cost of Plant all erected with foundations & Iron Stacks. Building not included.	Approximate	$ 43,000	$ 53,000	$ 48,000	$ 58,000	$ 56,000	$ 65,000	$ 57,000	$ 66,000	$ 63,000	$ 72,000
Cost of Plant per Horse Power.	"	$ 43	$ 53.	$ 48	$ 58	$ 56	$ 65	$ 57	$ 66	$ 63	$ 72
Cost of Fuel per H.P. per year.	"	$ 49.27	$ 49.27	$ 32.85	$ 32.85	$ 32.85	$ 32.85	$ 21.02	$ 21.02	$ 17.08	$ 17.08

ESTIMATED COST OF POWER PLANTS.

In place of the bobinet, bookbinders cloth might have been used, only the process of cutting would have been reversed in order to show the outline. For many purposes this might be preferable where a pebbled surface is desired, as it can be readily obtained in several patterns and sizes of the little elevations forming its surface.

In order that the finished plates could be polished, the cardboard was about four hundredths thick; the figures not too large for fear of imperfections in surface of castings; in fact the results were much better as their surface area approached uniformity. By moulding carefully in French sand the metal patterns were produced requiring but little care in finishing.

* * *

THE *New England Manufacturers Mechanical and Commercial Review* is the title of a new fortnightly, which hails from Worcester, Mass. We should be pleased to comply with the request to "comment favorably" on it if it were worthy of it, but we do not believe that journalism of this type, which is both sectional and political, can be an important factor in the field of mechanical publications. It contains little of interest to mechanics generally, and seems likely to be read only by those who expect their names to appear in its columns.

COPYRIGHT, 1897, BY THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY,

A practical journal for Machinists and Engineers, and for all who are interested in Machinery.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS.

411 AND 413 PEARL STREET, NEW YORK CITY.

ONE DOLLAR A YEAR, POSTAGE PREPAID, TEN CENTS A COPY.

FOREIGN SUBSCRIPTIONS ONE DOLLAR AND FIFTY CENTS A YEAR.

Fred H. Colvin, Editor.

F. F. Hemenway, Consulting Engineer.

Walter Lee Cheney, S. Ashton Hand,

Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 10th of the month preceding publication.

FOREIGN AGENCIES OF MACHINERY.

AFRICA.—Cape Town: Gordon & Gotch.—Johannesburg: Sherriff Swingley & Co.

AUSTRIA-HUNGARY.—Vienna: White, Child & Beney; F. A. Brockhaus; Lehman & Wentzel.—Budapest: Ormai & Co.; Jos. Schvarcz & Co.

AUSTRALIA.—Adelaide, Victoria: W. C. Rigby.—Brisbane, Queensland: Gordon & Gotch.—Melbourne, Victoria: Gordon & Gotch.—Sidney, N. S. W.: Turner & Henderson.—Townsville, Queensland: T. Willmett & Co.

BELGIUM.—Antwerp: L. Versrepen-Eliaerts.—Brussels: Librairie Castaigne, Montague aux Herbes Potageres, 22.

CHINA.—Hai Phong, Tonkin, Indo-China: E. C. Chodzko.

DENMARK.—Copenhagen: V. Lowener.

EGYPT.—Alexandria: G. Artuso Molino.

ENGLAND.—Birmingham: Chas. Churchill & Co., Ltd.—London: Buck & Hickman, 280-281 Whitechapel Road; C. W Burton, Griffiths & Co., 158 Queen Victoria street; Chas. Churchill & Co., 15 Leonard street; Chas. Neat & Co., 112 Queen Victoria street; W. H. Smith & Son, 186 Strand, W. C.—Manchester: Henry Kelley & Co., 26 Pall Mall.

FRANCE.—Paris: Boyveau & Chevillet, 22 Rue de la Banque; L. Roffo, 58 Boulevarde Richard Lenoir; Fenwick Freres & Co., 21 Rue Martel.

GERMANY.—Berlin: A. Usher & Co., 5 Unter den Linden; F. A. Brockhaus, 14 Oberwallstrasse, W.—Dusseldorf: M. Koyemann.—Mulhouse: H. Stuckelberger.

HAWAIIAN ISLANDS.—Honolulu: Hawaiian News Co.

HOLLAND.—Rotterdam: H. A. Kramer & Son.

INDIA. Bombay: Thacker & Co., Ltd. Calcutta: Thacker, Spink & Co.

JAPAN. Nagasaki: Lake & Co. Yokohama: Andrewz & George.

JAVA. Tegal: W. J. Amons.

MEXICO. City of Mexico: F. P. Hoeck.

NEW ZEALAND. Aukland: J. Flynn.

RUSSIA. Moscow: J. Block & Co.; G. Koeppen; Mellier & Co. St. Petersburg: Wossidlo & Co.; F. de Szczeyanski; Carl Ricker.

SPAIN. Barcelona: Librairie A Verdaguer. Madrid: Librairie Guttenberg.

SWEDEN. Stockholm: E. Hirsch & Co.; B. A. Hjorth & Co.

SWITZERLAND. Zurich: Mayer & Zeller.

TURKEY. Constantinople: V. L. Levy.

THIS PAPER HAS THE LARGEST CIRCULATION OF ANY PUBLICATION IN THE MACHINERY TRADE.

JULY, 1897.

CONTENTS:

More Exposition Notes. Henry Monk 327
Beam Dimensions and Load by Diagram. Henry Hess 330
Spur Gear Arithmetic, A. B. Babbitt 332
Practical Pattern Making (2), I. McKim Chase 333
How to Calculate, Design and Construct Electrical Machinery, Wm. Baxter, Jr. 335
Horse Power and the Power of a Horse. 337
Mechanism for Mechanics (6), Prof. Chas. H. Benjamin 337
Metal Patterns. Warren E. Willis 338
Estimating Cost of Power Plants, R. E. Marks 339
Looking After Details (Editorial). 340
Seen in Various Shops (2), A. Hardcase 341
The Hartford Convention and Extracts of Papers Read. 342
Uncle Jim's Philosophy. F. F. H. 345
One of the Modern Shops. 346
Centrifugal Force of Belting, R. Grimshaw 349
From Actual Practice. "Milo" 351
The Split Pulley Patent. 352
Sand Sifting Machinery, New Patterns of. Geo. D. Rice 352
Manual Training Schools, Wm. O. Webber 354
How and Why. 355
What Mechanics Think. 356
Manufacturers' Notes. 358
Fresh from the Press. 358

MR. FRED H. COLVIN, who has been the editor of MACHINERY since its inception three years ago, has resigned to become associate editor of *Locomotive Engineering*, and has been succeeded by Mr. Lester G. French, who is well fitted for the position by some ten years' practical experience and training. Mr. Colvin takes to his new field of work the best wishes of all his associates, and, we feel sure, of every reader of this paper as well.

Neither the ownership, management, nor policy of MACHINERY is affected by the above announcement.

* * *

I WISH to thank the readers and contributors of MACHINERY for their support during the three years (nearly) of its existence, and for their expressed appreciation of the articles by "Ichabod Podunk," "Chips" and "Jonathan Jones, Jr.", which I may as well acknowledge to have written from incidents in my own shop experience. I trust the same good-will and support will be accorded my successor.

FRED H. COLVIN.

THE drafting room is very apt to be considered as a non-producing department and as a kind of necessary evil, to be tolerated only because it isn't convenient to get along without it. One class of managers use the drawing room only to keep a record of the work done and the changes made, actually sketching the finished work for record instead of first laying plans and making the work accordingly.

These are the places where the cost of work could probably be greatly reduced by the use of carefully made designs and by not allowing changes to be made at will in the shop, to be afterwards recorded by the draftsman. The latter's lot is not particularly a happy one at best, but it is made much more miserable than is necessary or economical by such practices as these. Careful work here counts fully as much as in any department of the shop.

* * *

LOOKING AFTER DETAILS.

It is often the boast of managers and superintendents that they know every detail of their business and allow nothing to be done without their personal attention, pointing with pride to the many details which they look after and, possibly in the same breath, expressing regret that it leaves them so little time for other work, such as becoming acquainted with new tools or shop systems. Men who have grown up from the shop into responsible positions are very apt to be of this type, for it is as hard to drop details with which they have been familiar as it is to remember that there are others who can look after them just as well—perhaps better—and leave the superintendents time for more important things. It is well to know the details, so as to be able to examine them occasionally, but to attempt to follow them continually, is not only a waste of time but prevents attention to features of more importance.

By giving the men in charge of the various departments full control of them (of course, within reasonable limits) holding them responsible for the work of that department, and offering an inducement for economical management, the details will be looked after and the superintendent will have time to devote to subjects properly within his sphere.

Questions regarding the make of brooms to be used; whether the floor shall be sprinkled before being swept; whose files shall be bought; how often windows shall be washed, and numerous other problems of similar grave importance take a great deal more time than can well be spared. These questions must be decided, of course, but they belong to the department in which they occur and should be decided by the one in charge.

The most successful managers are those who manage men, not things. By selecting the right heads of departments, encouraging them to do their best by showing in a substantial manner that their work is appreciated, and devoting the time that is too often spent in trifling details, in becoming familiar with the latest practice and methods, the manager or superintendent can suggest improvements to the various departments that far outweigh the whole cost of some of the details referred to.

Before giving too much time to insignificant details, which are often of little consequence one way or the other, it is well to consider whether the amount involved is worth the mental worry and the time it takes.

There are men so constituted that they cannot be content to allow others to decide on any details, however small, and it is probably useless to try to change their ways. Those who are just coming into responsible positions, however, may see the errors of others and profit by them.

* * *

A CORRESPONDENT in Germany writes us to warn machine tool builders against the visit of two Germans who intend going through the machine tool shops in this country, nominally to buy, but practically to collect information for use in competition with our manufacturers.

SEEN IN VARIOUS SHOPS.—2.

SPRAGUE ELECTRIC ELEVATOR CO.

One of the special features of the elevators built by the Sprague Electric Elevator Co., of East Orange, N. J., is the patent ball nut, shown in Fig. 1. The thread of this nut and its screw are of special design and run with ½ inch balls between them to take the end thrust. As these balls are rolled forward by the motion of the screw they must escape, one at a time, in some way as fast as they come to the end of the thread, to make room for those behind them. This means of escape is provided by a thin curved tube, that the balls enter at *A* and discharge at *B* into a hole drilled through the nut near its outside surface, to its other end where another tube like *A B* conveys them back into the space between the threads; making one endless course filled with balls so that the screw can be turned indefinitely in either direction and no crowding of the balls or vacant places result. In the cut, the tube *A B* is partly removed to show it more plainly. After the tube *A B* has been properly shaped and fitted, the space around it is filled with babbitt and finished off smooth and even with the end of the nut. This mass of babbitt containing the tube can be removed at any time to obtain access to the balls. At first this space for the tube was worked out and finished by hand, but the fixture devised by Mr. Hugh R. McGregor, the superintendent, for cutting it out on the shaper, is worth mentioning and is shown in Fig. 2. The usual table is removed and this fixture bolted on in its place. *C* is a special chuck in which the lower end of the nut *D* is held by set screws and both revolved by means of a worm gear *E*, driven from the regular feed motion. A cam surface on the bottom of *C* rests upon a small roller so that when *C* is revolved, it slides up and down on its splined shaft according to the shape of the cam, carrying the nut with it, while the tool is at work on its upper end planing out the desired shape, almost as readily as if it was on straight work. As this fixture was not in use, the cut was made from a small photograph previously secured by one of the machinists, Mr. Frank A. De Hart, who was kind enough to make the others especially for this article; and considering that they were taken before the machinery started, at 6.30 a m., and with light so poor that an exposure of two minutes and ten seconds was required with extremely rapid plates, the results are very creditable.

The threads in these nuts are ground after hardening by a very interesting machine, built especially for this work, but requiring too much space to describe in this article. Fig. 3 is another of Mr. McGregor's kinks, used for drilling the holes in the ends of the guide rails on which the elevator catches. Fig. 4 shows the same fixtures and its attachments in use, drilling six $\frac{9}{16}$ inch holes 1½ x 3¼ inches apart, simultaneously, and is briefly described as follows: The taper shank fits the drill press spindle, and runs freely in its bearing through the center of the square block *F* and has a nut and washer on its lower end. Two of the six little spindles *G* are driven direct from a gear secured to the taper shank, making it necessary to use left-hand drills in them; but the other four being driven from these two run right handed. Each drill is held by a screw set into its shank, and six more screws *H* with check nuts provide adjustable stops for the drills to butt against and prevent them from pushing back into their sockets. *J* is clamped solidly to the column of the drill press and prevents any rotary motion of the block *F* with its six drills that are fed up or down through it as if it were a single drill. The work *K* is held by the vise *L*, and the six bushings guide the drills and produce a duplicate set of holes in each piece.

FIG. 1.

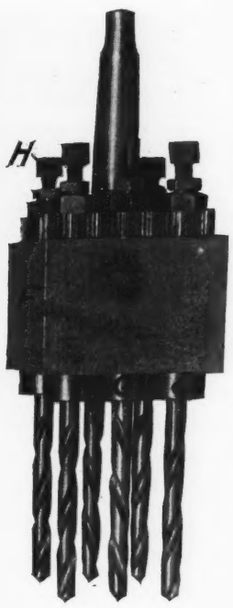


FIG. 3.

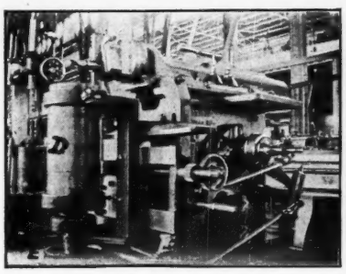
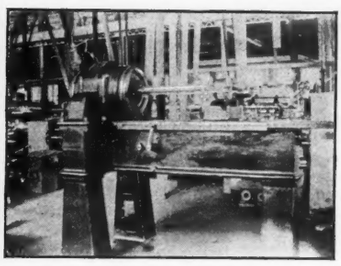


FIG. 2.



GRINDING LATHE.

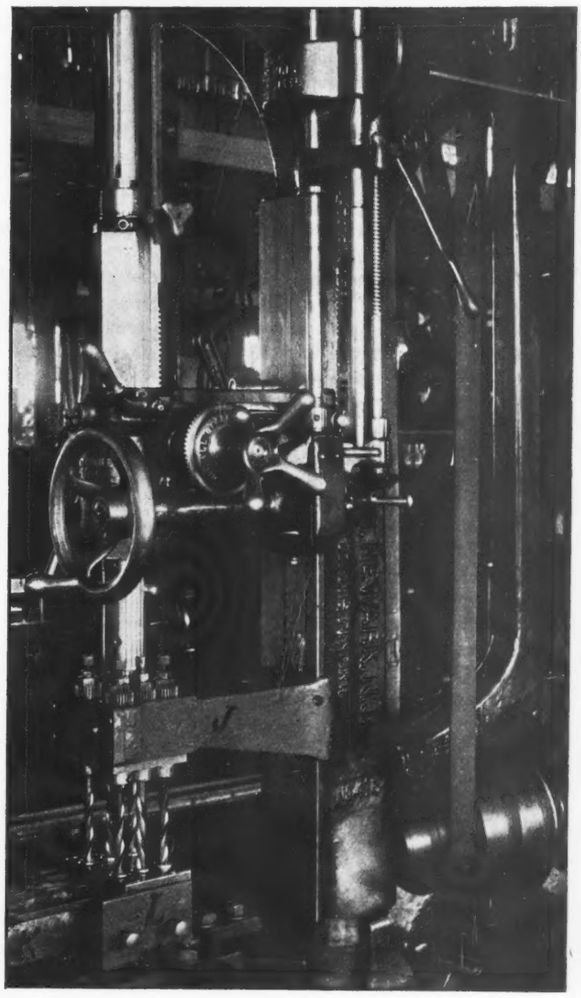


FIG. 4.—SHOWING DRILLING HEAD IN USE.

The care taken in fitting up the elevators and making the parts of them in duplicate, was quite as interesting and noticeable as the special machinery and fixtures, that enable good work to be quickly produced. The shafting is divided into conveniently arranged sections and driven by motors receiving power from the steam plant of the works.

J. S. NEWELL & CO.

It is not very often that one sees a woman at work in a machine

shop, and when he does, the novelty of it is quite apt to excite his curiosity, as it did mine when I found Miss Rachel Doblin at work in the shop of J. S. Newell & Co., 23 West First street, South Boston, Mass. It was not a large shop, and the machinery and other things, with the usual amount of dirt, were packed in so thick that I had been in the shop some time before I noticed her. After watching her work a few minutes I concluded that the novelty of the case was not the only thing to attract attention. In the first place, she was working at a lathe on cast iron—a job that every machinist knows is a dirty one, yet there was not a spot of dirt on her face at half-past eleven. "Yes," she said, "I used to get my face dirty enough, but have learned to keep my hands away from it, now." Evidently she is the only one in the shop who has. The quickness of her movements suggested rapid work as compared with what a man would do on some kinds of work.

Perhaps there are others as inquisitive as myself who would like to know how she happened to take up the work, and her own answers explain this best.

"I used to work in a wrapper factory part of the time, and did the drawing for the shop here also; and when I got a chance would come into the shop to work just for the novelty of it. The astonishment of strangers who see me here is quite amusing to me, besides it is well for one who has to do the drawing to know something about doing the work. No, I don't intend to make it my life work; it is interesting but too dirty for a woman, and I don't grasp the technicalities as I ought."

In spite of her surroundings, she seemed to be a woman with a woman's traits.

The foreman's answers, when questioned concerning her, are also interesting. "She makes a good 'draughtsman,' her touch is more sensitive than a man's and she makes a nice drawing, but a woman can never do many parts of machine work—she can not understand it as a man would. She follows instructions to the letter and learns quickly—one telling is usually sufficient. I can depend upon her to be here when wanted; she stays in her place when in the shop, which is more than most boys will do, is always on time and she don't get drunk and come back unfit for work for the first three days of the week. Of course there is more danger of accident from the nature of a woman's dress and I wouldn't have a lot of them in a shop together."

I remember seeing one full-fledged lady machinist before, and know of quite a number who run engines, but an incident that happened in Boston recently, as related to me by the builder of the engine in question is amusing:

"The cylinder-head of an engine built by us several years ago, blew off, and we sent a man to fix it, which was the first repairs made on it since it was built. He found a 'lady engineer' in charge, and the engine was so badly worn that he told her it needed a thorough overhauling before it would be fit to run again." "Why," she said, "it hasn't been running only seven years; it ought to last longer than that, hadn't it?"

A. HARDCASE.

* * *

ERRATA.

IN all calculations involving horse power, it should be remembered that the *time* element is of great importance, and that a horse power is equivalent to the lifting of 33 000 pounds one foot high in *one minute*. First find the foot pounds of work done, then divide this by the number of minutes in which the work is done, and lastly divide by 33 000, which gives the horse power per minute. This explanation was made necessary by a misunderstanding of our answer to question 38 in the June issue.

MR. J. J. MCCABE informs us that our reference to the double spindle lathe in connection with the catalog of Dietz, Schumaher & Boye was an error, as the patents are owned by him. As the catalog did not mention Mr. McCabe in connection with this lathe, we took it for granted that they were the originators.

* * *

THE MECHANICS' INSTITUTE, of San Francisco, informs us that their thirtieth exposition will be held from August 17th to September 18th inclusive. It will be held in the Mechanics' Pavillion, which has a floor space of three and one-half acres. Floor space, power, water and lighting are free to exhibitors. It is the aim of its promoters to induce Eastern manufacturers to embrace this opportunity of placing their goods before the consumers of the Pacific coast.

THE HARTFORD CONVENTION.

The meeting of the American Society of Mechanical Engineers was probably graced with the largest attendance of any spring meeting ever held, over 380 members and guests being registered. It is sixteen years since Hartford entertained their society and no effort was spared to make this convention a pleasing memory to those who attended. The hotels were over-crowded—due to a long drawn out session of the Legislature, who usually leave the city in peace earlier in the season; but little things of this kind did not prevent the engineers from having a good time.

Mayor Preston welcomed the Society to the city and President Warner replied in one of his characteristic speeches. In speaking of Hartford shops, he said: "We, of the wild and woolly West, (he is of Warner & Swasey, Cleveland, O.) never dare say that we build the best machines in the world, but have to be content with saying 'they are as good as Pratt & Whitney's, and —— we sometimes lie about that.'" The reception given by Trinity College was a great compliment to the Society and duly appreciated, as was the issuance of special tickets to members and their ladies, for use on any street-car line in the city.

POPE MOTOR CARRIAGE, ELECTRICALLY DRIVEN.

The horseless carriage of the Pope Motor Carriage Co., and the self-propelling steam fire engine also attracted attention. Brief extracts of such papers as seem likely to interest the readers of this paper follow:

DIAGRAMS FOR RELATIVE STRENGTH OF GEAR TEETH.

FORREST R. JONES, MADISON, WIS.

These diagrams were constructed with a view to facilitating the determining of the sizes and pitches of gears which are suitable to withstand a known or assumed pressure transmitted to them by an intermeshing gear. Since the conditions affecting the magnitude of the force which can be safely applied to a gear by its mate are so numerous and variable, no attempt has been made to take them into account in the diagrams, this being considered a function of the designer. The principal quantities thus left out of the diagrams, are: Speed of gear; inaccuracy of alignment and of tooth forms, both tending to localize the pressure against the tooth over a small area of the working surface; the presence of foreign substances between the teeth; liability to shocks; and the number of teeth in working contact.

The assumption is made, for convenience of calculation, that the pressure is applied to the tooth at its top, uniformly distributed across the width of the gear face, and normal to the radial plane of the gear which passes through the center of the tooth. The relative values of the force so applied, the pitch, and the maximum fibre stress induced, are given in the diagrams.

At the risk of getting the cart before the horse, the methods of using the diagrams will first be illustrated by a few examples, in order to show their purpose.

Figs. 1 and 2 are for gears having a face one inch wide, Fig. 1 being for smaller pitches, from about .25 of an inch up to about 2 inches, and Fig. 2 for pitches from 2 inches up to a little more than 6 inches. Figs. 1 and 2 can readily be used for gears having any width of face expressed in inches.

Figs. 3 and 4 are for gears having a face width equal to the circular pitch of the teeth, and can be used for gears in which the face width bears any given ratio to the circular pitch. The same ranges of pitch are covered in Figs. 3 and 4 as in Figs. 1 and 2, respectively.

Let it be required to find the pitch of a gear 18 inches in diameter, 4 inches face, working at 4 000 pounds maximum stress in the material, to withstand 2 000 pounds pressure at its point. This gives a pressure of 2 000 ÷ 4 = 500 pounds per inch of width of face. In Fig. 1, on the right hand scale, marked "pounds pressure at tooth point," find the 500 pound line and follow it to its intersection with the 4 000 pound fibre stress line; from this point drop down to the curve marked "18 inches diameter," and thence to the scale on the left of the diagram, thus obtaining a reading of 2.25 diametral pitch, or about 1.4 inches circular pitch.

Again, suppose a pressure of 4 550 pounds is to act on a gear of 8 inches pitch diameter and 7 inches face, the limit of fibre stress being 6 000 pounds per square inch. The pressure per inch of width in this case is 4 550 ÷ 7 = 650 pounds. By the same method as before, following the 650 pounds pressure line to its

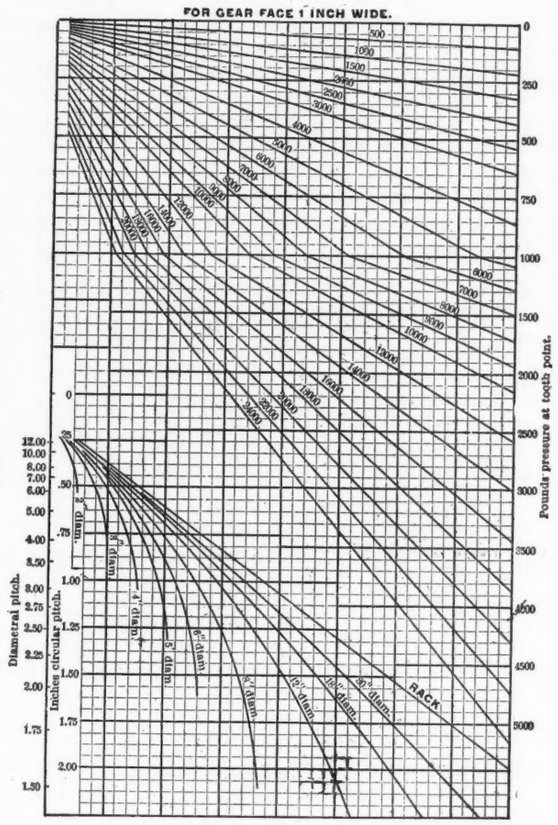


FIG. 1.

intersection with the 6 000 pounds fibre stress line, and thence toward the bottom of the diagram, it is found that the vertical line does not cut the 8 inches diameter line, but falls to the right of it, the latter terminating at 1.5 diametral pitch, this being the greatest pitch that can be used when the number of teeth is not less than twelve, which is the lower limit in the diagrams. The fact that the vertical and diameter lines do not intersect shows that no gear having twelve teeth or more can be designed to fulfil the conditions given. With a fibre stress slightly greater than 6 000 pounds per square inch, however, a gear of 1.5 diametral pitch will answer.

It can doubtless be readily seen that if, of the four factors—pitch diameter of gear, width of face, pitch, and fibre stress—three are given, the other can be determined by the aid of the diagrams.

The change of direction of the fibre stress lines at the 1 000 pounds pressure line in Fig. 1, and the similar changes in the other figures, require no consideration in their use, the break in the lines being made simply to give their intersections with the pressure lines as much distinctness as possible, and, at the same time, to keep the length of the diagram conveniently small. It should be noted, however, that a change of pounds per inch is thus made necessary on the pressure scale, the change occurring at the pressure line where the angle is made in the diagonal lines.

* Diagrams show relation between pressure at tooth point, stress in outer fibre, and pitch of a gear tooth. Figures in diagram above "Rack" indicate fibre stress—those below, diameter of gear.

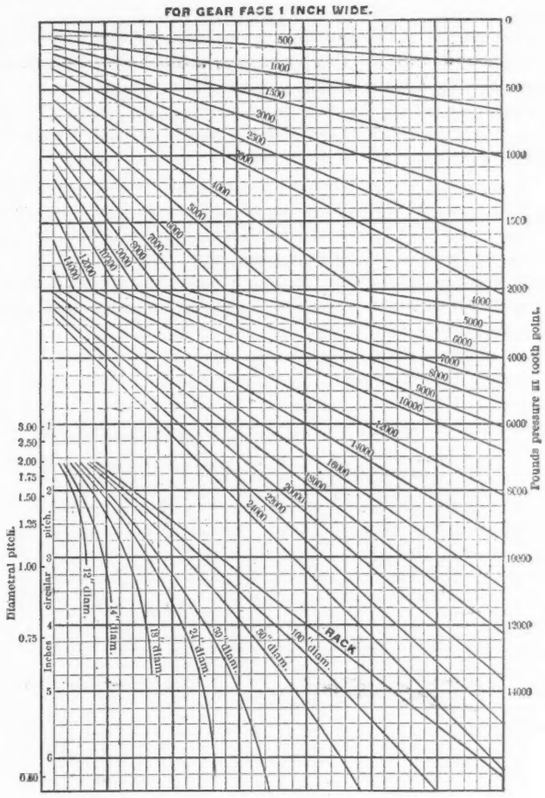


FIG. 2.

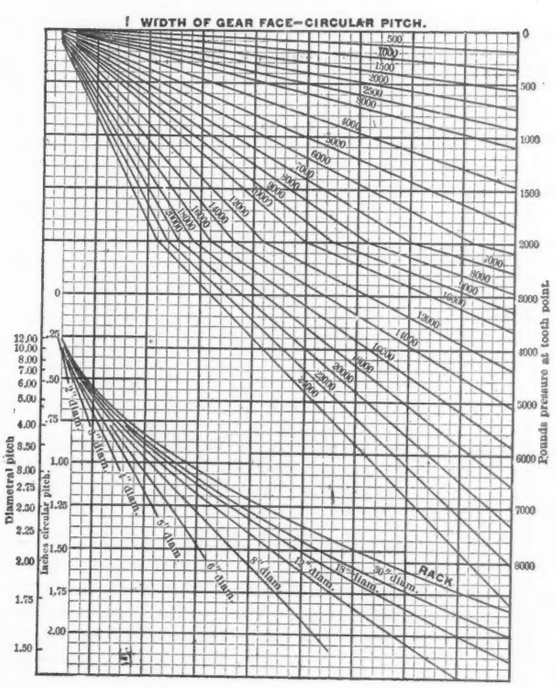


FIG. 3.

The use of Figs. 3 and 4 for a width of face equal to the circular pitch, is the same as the preceding example, except that the pressure for a width of face equal to the circular pitch is read on the scale of pressures at tooth point, instead of the pressure per inch of width as was done before. Thus, for a gear 30 inches in diameter, whose face width is to be three times the circular pitch, to work at a fibre stress of 14 000 pounds per square inch, under

a pressure of 90 000 pounds at the tooth point, we have 90 000 ÷ 3 = 30 000 pounds pressure on a width of face equal to the circular pitch. Following the 30 000 pounds line from the right hand side of Fig. 4 to its intersection with the 14 000 pounds diagonal line, and thence to the 30 inches diameter curve, gives 5.75 inches circular pitch, which is something less than .5 diametral pitch.

The method of determining the necessary data for plotting the curves was as follows: The outline of a tooth of .5 diametral pitch was carefully developed by the use of a rolling circle having a diameter equal to the radius of a 15 toothed gear of the same pitch, giving a tooth practically the same as used by the Brown & Sharpe Co.

For 14 gears of the same pitch and width of face, varying from 12 teeth to a rack, the number of teeth being selected so as to increase this as nearly as possible by equal increments from its value for 12 teeth up to that for a rack. By plotting the values thus obtained, the curve of Fig. 5 was determined. The value for a rack is not much greater than that of a 300 toothed gear, however, being 4 080 pounds for the rack.

By the aid of this curve and making use of the fact that when a number of teeth and the width of a gear remain constant, the strength of the teeth varies as the circular pitch, the curves of Figs. 1 and 2 were laid out. And by taking into account the

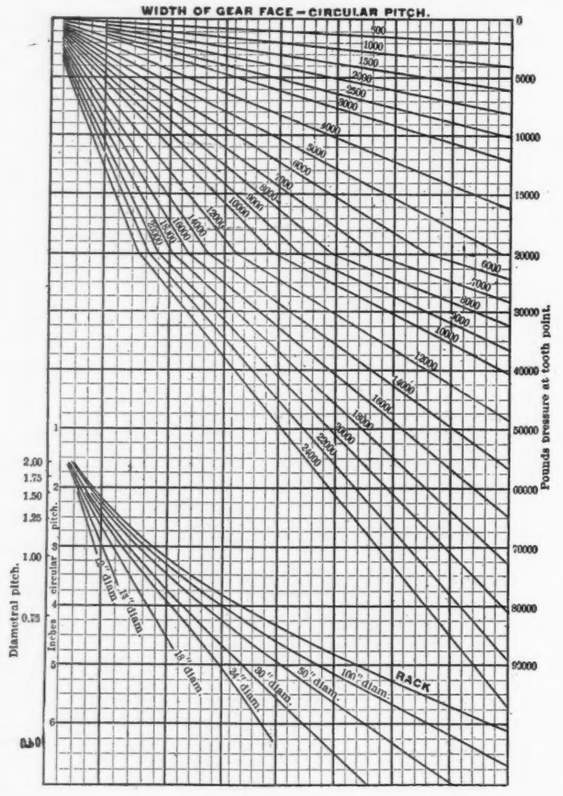


FIG. 4.

property that when the number of teeth is constant, and the width of face bears a constant ratio to the circular pitch, the strength varies as the square of the pitch, the curves of Figs. 3 and 4 were determined.

Examples of gear teeth broken in actual service are not readily found in connection with such data of speed and power transmitted, as are necessary for finding the fibre stress by the diagrams or any other method. The results of tests on cast iron gears, given in Brown & Sharpe's "Practical Treatise on Gearing" are given below, together with some added data, namely:

— Diametral pitch.	Circular pitch Inches.	Width of face Inches.	Number of teeth.	Pitch diam. Inches.	Revolutions per min.	Veloc. at pitch cir. Ft. per min.	Observed breaking pressure at pitch circle Pounds.	Stress in outer fibre Pounds per sq. inch.
10	.3142	1 1/16	110	11	27	78	1,060	33,000
8	.3927	1 1/4	72	9	40	94	1,460	29,000
6	.5 36	1 5/16	72	12	27	85	2,220	24,000
5	.6283	1 1/2	90	8	18	85	2,470	20,500

circular pitch, pitch diameter, speed at pitch circle, and stress in outer fibre.

The fibre stresses higher than 24 000 pounds given in the table were obtained by temporarily constructing diagonal lines for higher stresses than given in the diagrams. In determining the values of the fibre stresses given in the table, it was assumed that the turning force at the pitch line acted at the point of the tooth. While this is undoubtedly not true, and gives a fibre stress not near the actual amount, it still serves as a guide for designing gears of similar dimensions. If it is possible to obtain similar data for larger gears of cast iron, an idea of the working strength for the range of pitch covered can be obtained. For steel and other strong metals, the fibre stress would, of course, be taken much higher.

MOLDING GEARS.

In the discussion following this paper, Mr. Gus C. Henning described the method, now being used by the Walter Scott Printing Press Co., of Plainfield, N. J., for casting gears on their presses.

An iron pattern is made and the teeth cut correctly, in fact a first-class gear is made for a pattern. This is then carefully molded in a very hard or refractory sand—almost a clay—and the whole then put into an oven to bake, pattern and all. The heat expands both the pattern and mold and forces them into close contact. As they cool slowly they contract, and when cool enough to handle the pattern can be lifted from the baked mold without rapping. Then, with the mold still fairly hot the metal is poured in, which avoids the chilling effect of the cold mold. This produces gears so nicely molded that they run well on printing presses and can hardly be distinguished from cut gears.

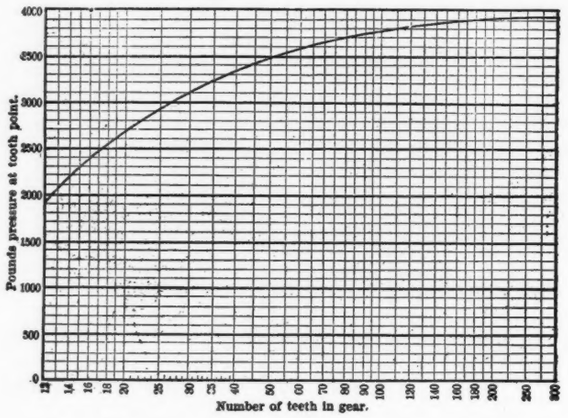


FIG. 5.

ELECTRICITY VS. SHAFTING IN THE MACHINE SHOP.

CHAS. H. BENJAMIN, CLEVELAND, O.

This is a sequel to Prof. Benjamin's paper at the December meeting, on "Friction Horse-Power in Factories." The tables give quite a complete summary of his investigations, and with his conclusions, are sufficient to get an idea of the case in the instances cited.

TABLE I.

Number.	1	2	3	4	5	6	7	8	9	10
	Total Line Shaft. in feet.	Diameters of Line Shafts, Inches.	Number of Belts.	Average Width of Belts.	Number of Machines.	Number of Men.	Total Horse Power.	Horse Power to Drive Machines.	Horse-Power to Drive Shafting.	Useful Horse-Power per Machine.
1	1 130	2½ 2¾ 4 6	89	4	.....	.....	400	243	157	.....
2	580	3 3½	28	6	18	78	74	17	57	.....
3	530	2½ 3	53	5½	43	152	88.6	13.3	25.3	.310
4	1 460	2½ 3 4	92	4½	69	80	59.2	11.3	47.9	.164
5	1 120	3	141	4	68	300	112	48	64	.707
6	1 065	2 3 4	192	4	123	225	168	77	91	.627
7	748	1½ 1¾ 2 3	217	3	250	200	40.4	19.7	20.7	.790
8	500	2 3	335	3	313	226	74.3	34.3	40	.109
9	990	1¾ 2½	217	3	258	100	47.2	22.7	24.5	.881
10	2 490	2 6	521	3	454	400	190	82	108	.180
11	1 472	2 3 4	484	3	179	350	107	32.5	74.5	.181
12	1 800	2 2¼ 2½ 3	486	3	428	320	241	127	114	.296

TABLE II.

Number.	1 First Cost of Shafting and Belting.	2 First Cost of Generator and Motors.	3 Difference in First Cost.	4 Horse-Power Lost by Electric Transmission.	5 Horse-Power Lost by Shafting Transmission.	6 Net Saving by Electricity. Horse Power.	7 Saving in Dollars per Year.	8 Pay Roll per Year (Estimated).
1	.....	.....	.....	121	117	No gain	.....	.....
2	3 650	7 150	+ 3 500	9	49	40	2 400	39 000
3	3 750	3 000	— 750	7	21	14	840	76 000
4	7 450	2 100	— 5 350	6	42	36	2 160	40 000
5	7 700	7 000	— 700	24	53	29	1 740	150 000
6	8 550	10 950	+ 2 400	39	74	35	2 100	112 500
7	2 700	4 300	+ 1 600	10	16	6	360	100 000
8	4 000	7 000	+ 3 000	17	32	15	900	113 000
9	4 000	5 000	+ 1 000	12	20	8	480	50 000
10	9 650	18 000	+ 8 350	41	89	48	2 880	200 000
11	7 550	7 000	— 550	16	64	48	2 880	175 000
12	8 400	25 000	+16 600	64	90	26	1 560	160 000

He says: "In estimating the cost of generators and motors for these same shops, it is assumed that a generator will be required having a power 50 per cent. greater than the net power used by the machines when the shop is running at full capacity, and that the aggregate power of the motors should be double this. It is further assumed that the motor unit will be from 5 to 10 horse-power in the shops doing heavy work, and not less than 2 horse-power in the shops doing light work. The cost of electric motors may be roughly classified as follows:

Horse-power of motor.....	2	3	5	10	20	40	50	65	75
Cost in dollars per HP.....	65	60	45	35	25	20	17	16	15

The figures in column 2 of Table II. thus show what might reasonably be expected as to the cost of generators and motors for each establishment. No account has been made in the one case of the cost of counter-shafts and secondary belting, nor in the other of conductors, switches, and such counter-shafts as might be used, one omission being allowed to offset the other.

Column 3 shows the differences between the values in the two preceding columns, the + sign indicating greater first cost for electricity, and the — sign greater first cost for shafting transmission. It will be noticed that in general the electrical transmission has the greater first cost, but in establishments where the amount of shafting is out of all proportion to the useful work done, electricity has the advantage even here. (See shop No. 4) In shops like Nos. 10 and 12, the machinery is compactly arranged and the cost of shafting relatively light.

If there is any unfairness in the above figures, it is in over estimating the electrical cost, since the writer desires to be conservative.

The figures of column 4 of Table II. are derived from those in column 8 of Table I. by assuming a combined efficiency of two-thirds for generators and motors. The power lost in shafting transmission, column 5 and Table II., is obtained from column 9 of Table I., by deducting ten per cent. of gross horse-power for engine friction.

The net gain in horse-power by using electric transmission is shown in column 6. Allowing $60 per horse-power per year as the gross cost of power delivered, we obtain the results in column 7 for the saving in dollars per year.

Some one may object that these calculations are rough, and based on insufficient data. Even if we admit this, two facts can still be regarded as proven:

1. That the first cost of electrical machinery is usually greater than that of shafting and belting.

2. *That the saving in power in most machinery establishments would pay for the additional cost of the electric plant in from one to five years.*

A saving of from two to five per cent. in the pay roll is of more importance than any saving that is likely to be effected in the power plant.

In some shops the power cost represents only about one per cent. of the total expense of running.

The question of the advantage of introducing electricity hinges not upon efficiency of transmission, but upon the effect on the output of product per man and per machine.

The different points to be considered in determining how electricity affects general economy of production may be classified as follows:

1. General arrangement of machinery to facilitate handling of work.

2. Clear head-room for the use of electric cranes and small hoists.

3. Light and cleanliness.

4. Control of speed.

5. General flexibility of the system.

6. Use of electricity for other purposes than power.

The whole shop should be planned with a view to handling the product with the least waste of time and labor, and electricity makes this possible. Large machines may be put in any position and at any angle, or, if need be, may be transported from place to place to accommodate the work. The power plant may be located in the most favorable place for taking care of coal, water, and ashes, and the power distributed to any building or buildings, with but little loss.

As another result of our long subjection to ordinary methods of conveying power, we have come to regard a machine shop as necessarily dark, a synonym for all that is black and dingy. A glance at the shops of some of our electrical establishments will convince anyone that this is a mistake.

Shops like those of the Crocker-Wheeler Co., the Westinghouse Co., etc., have been called "show places;" but at least they *show* the way from darkness into light, and should receive credit for it.

The belt is a dust carrier as well as a power carrier, and nothing can be kept clean in its vicinity. When we add to this the shadows cast by the shafts and belts themselves, we have a condition of things which tends to mistakes and poor work, and cannot be without a corresponding moral effect on the workman.

The partial or entire absence of overhead belts, and the diffused light reflected from whitewashed ceilings and walls, will cause an improvement in both quantity and quality of output which will prove a strong argument for electricity.

One of the minor advantages of direct connected motors on large machines is the possibility of easily and quickly adapting the speed of the machine to the kind of work being done. On large boring mills and lathes, especially when facing up work, this may be a factor of considerable importance in determining the cost of production.

The ease with which the electric system of transmission may be adopted or extended is one of the strongest arguments in its favor. The extravagant consumption of power, as noted in the former paper, is probably due, in most cases, to a gradual extension of the shafting system by lengthening shafts beyond a reasonable limit, to the turning of corners with bevel gears, and to the use of turned and twisted belts, with their attendant evils in the way of guide pulleys.

The writer has had under his personal observation motors which have run for years whenever called on, have required less care than an ordinary loose pulley, and have cost almost nothing for repairs. An electric motor, if properly designed and constructed, requires no more care than any piece of machinery running at the same speed.

Only lately the writer saw a railway motor driving a grinder for pulverizing furnace linings, in an atmosphere so full of grit and dust that the operator had to keep his mouth and nose masked. The motor under a street car will convince the most superficial observer that there is nothing to be feared on this score.

* * *

UNCLE JIM'S PHILOSOPHY.

The shop's philosopher—that's uncle Jim—put it about this way, and it isn't a bad way to put it, either.

Uncle Jim is one of those good-natured bodies that are generally grumbling in a good-natured way about something the Old Man is doing, or isn't doing, it does not matter much which. Every machine shop in the land has its Uncle Jim. There is no place for him in the big shop that gets wound up and the key thrown away, and runs tranquilly till the weight gets to the bottom, but every progressive little shop with its ten or twenty men has its Uncle Jim; could not get on without him, not in any way ever found out yet.

"There," said Uncle Jim, "the Old Man's doing just what he has been doing for the last twelve years to my certain knowledge, and I have been calculating that he has lost in that time two thousand dollars, and that's enough to pay for the two new lathes he is always wanting and never getting. Just thrown away two thousand dollars, and now he is throwing away some more."

"What is that, Uncle Jim?"

"Well, you know how much the work here runs to using short shafts for all sorts of purposes. Look over at Dan's lathe. There's just fifty-two pieces of 2-inch round iron 19 inches long. Just been cut off in the blacksmith shop and brought in. That cost something. Rollers for the job on roller swingers up at the new mills. Got to be turned pretty nicely, all to one size. Doesn't make much difference just what that size is, but there mustn't be but one size. Now Dan will center them, and straighten them, and square them up, and take two cuts over them, and it's all going to take time. The iron had to be bought, and Dan will do better than he generally does if he doesn't spoil a couple of them—that is what the two extra ones are for, anyhow—and when the fifty rollers are done they will cost more than you think for. But the Old Man has done things in this way so long that he will not see where he is wrong. Now here is Allison right in the business of making shafting. Sell it to you mighty cheap and make money at it, Allison can, because he is all rigged up for doing just that kind of work. What the Old Man ought to have done was to have ordered some 2-inch shafting in long lengths, and cut it up into better finished rollers than Dan will ever turn out of those short pieces. Saved half the cost that way, gave the mills a better job and made something himself. And its just the same with lots of other short shafts, and such like, that he is making all the time. Trouble with the Old Man is he never thinks. You have got to do some thinking to run a little machine shop no bigger than this, in these times; that is if you make any money. Gone right along, this thing has, for years, wasting the money of the shop."

"Well, but Uncle Jim you have been the Old Man's best friend and principal adviser for years. Seen him throwing away money all that time in this way and never told him of it. Is that square?"

"Well—er—you see I never thought of it before. Told him in a minute if I had only thought of it."

* * *

ONE OF THE MODERN SHOPS.

The new shops of the Garvin Machine Co., at Spring and Varick streets, New York, contain many things of interest to the mechanic who is after new ideas and improvements, and even a brief visit discloses convenient and desirable points. The building is seven stories in height, and has windows on all sides (excepting the lower floors, which have one side blocked by dwelling houses), and is very light and airy in consequence. It contains over 100 000 square feet of floor space.

Power is obtained from a plant several blocks away, and each main line shaft has an independent electric motor coupled to it, making each floor independent as far as driving is concerned. There are seventeen motors in all, three of 20 HP. each are used for the elevators, three in number. The remaining fourteen motors, aggregating 160 HP., are distributed among the different departments, obviating any belt holes for communicating fire, or the vertical shaft, which is also a nuisance in many ways. The lighting is also electric, of course; incandescent lamps being used for the most part, with a few arc lamps where the conditions seem to demand it. All the modern devices for safety are employed, electro-pneumatic fire detectors, watchman's clock, time clock, etc., etc.

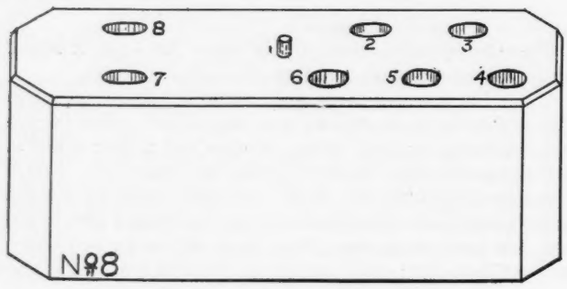
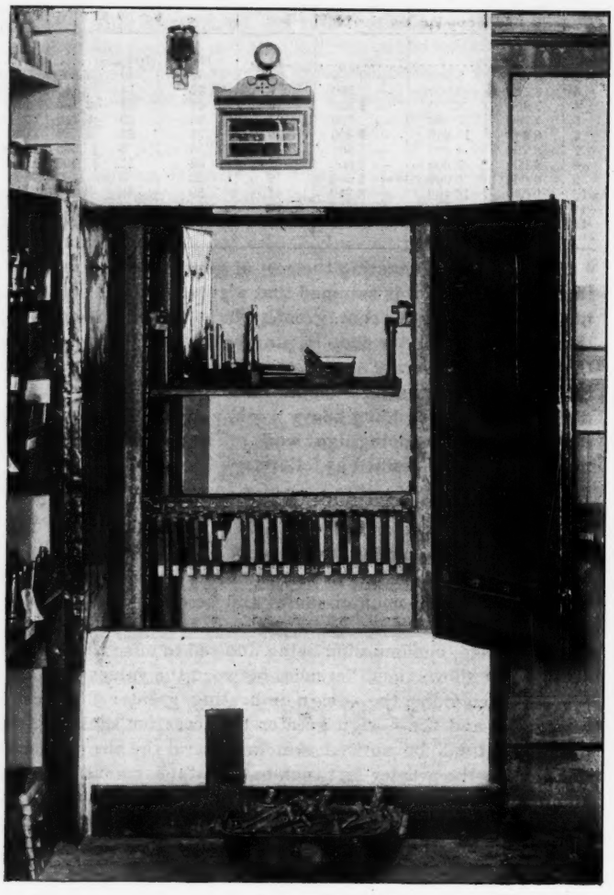


FIG. 1. (PAGE 348).

There is a regular telephone system installed, having a central station with a capacity of 50 connections, 32 of these are already in use, and this number is constantly being increased. This is next to the long distance telephone service, as shown in the cut, and both are attended by the same boy. The usual interior telephone system would not be satisfactory on account of the use of so much electric current in the building.

One very convenient scheme is a continuously travelling conveyor, which goes from the basement to the top floor, in a brick shaft, which has fire-proof doors on each floor, to prevent fire being communicated by this means. At frequent intervals the conveyor has swinging shelves and tappets, which ring a bell when they pass the different floors. These tappets make electrical contact and ring the bell shown above the conveyor, 20



TOOL ELEVATOR—TOOLS ON TRAY AND TAPPET SET FOR SECOND FLOOR.

seconds before the conveyor reaches the floor for which it is carrying tools or supplies. This conveyor passes through the tool-room (which is on about the middle floor), and when a man wants a tool he goes to the conveyor, writes an order on a small slip of paper provided there, lays this and his check on the first shelf that comes along and sets the tappet to ring the tool-room bell. The boy in charge of tools hears the bell, takes the order and check and sends the tool or tools down on the next shelf that happens along. This saves a tool-room on each floor and is a time-saver in several ways.

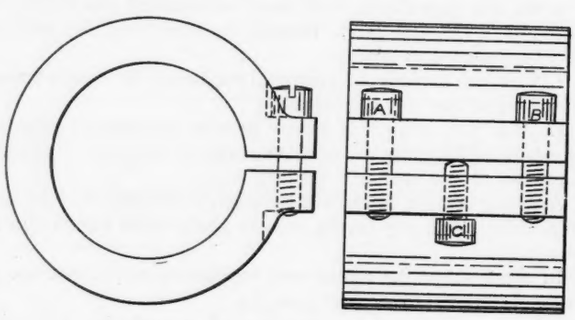
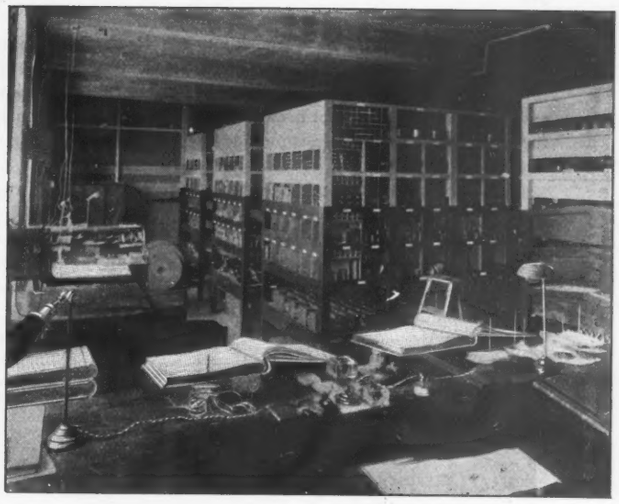


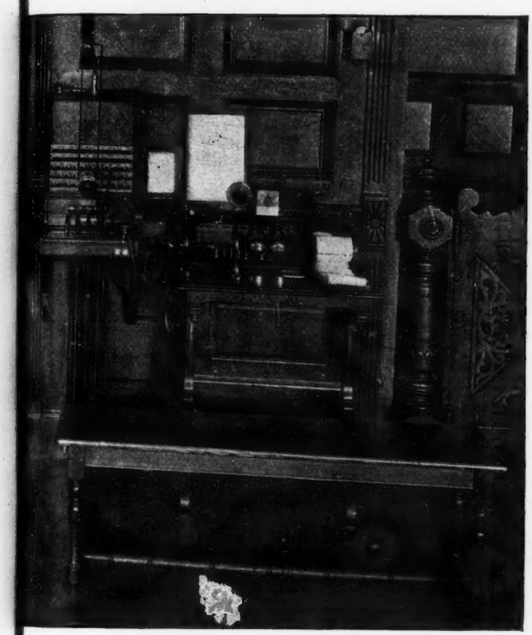
FIG. 2.—ADJUSTABLE GAUGE (PAGE 348).

The tool-room is run very systematically. The stock of bolts, nuts, washers, etc., is kept in stock books, which show at a glance the number on hand, giving an exact idea of the sizes to be ordered, so that no time need be lost in waiting for supplies. As no stock is given out without an order and the orders are filed away to be bound in

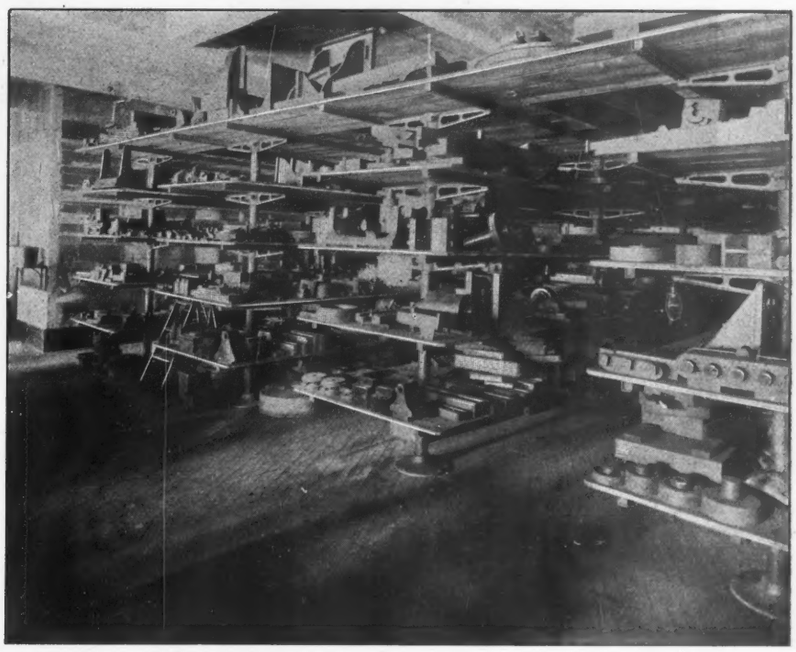
PATTERN ROOM.



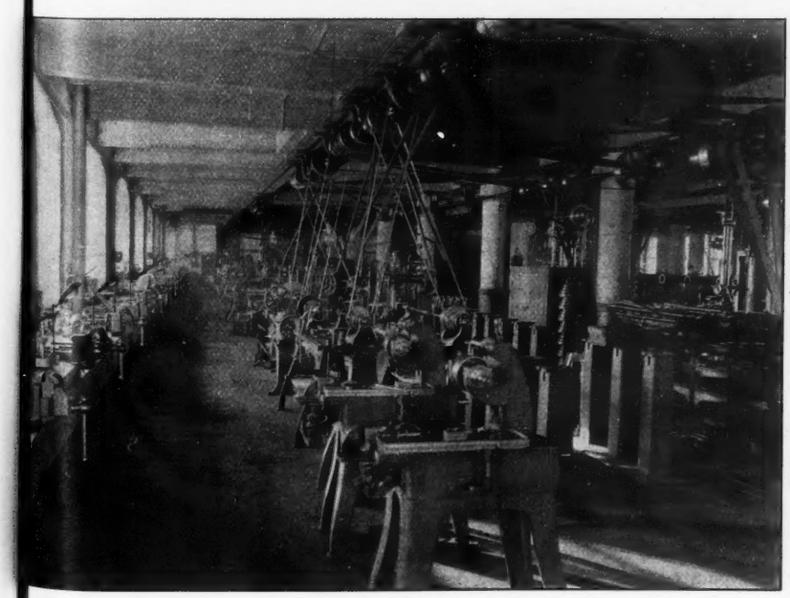
STOCK ROOM.



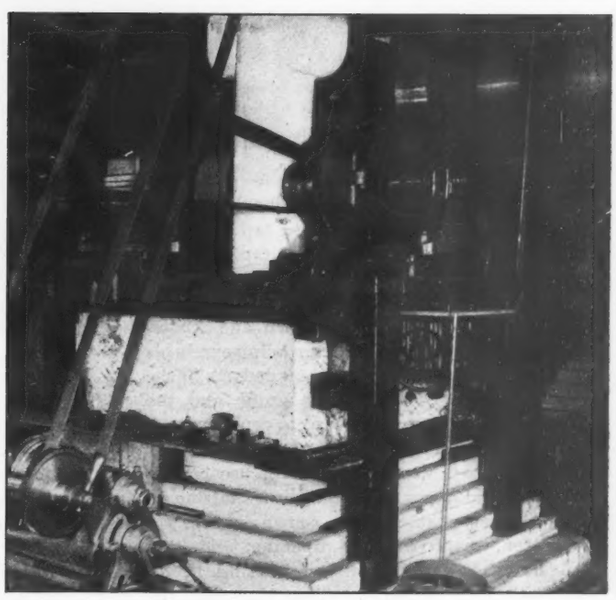
TELEPHONE STATION.



PATTERN STORAGE.



CORNER OF MACHINE SHOP.



MOTORS IN BASEMENT.

VIEWS IN THE GARVIN MACHINE COMPANY'S SHOP.—SEE PAGE 346.

weekly books, there is a check on all stock figures and no "watering" is apt to occur. There is also a record kept of broken tools, showing date and number of the workman, so that it is easy to pick out the tool breakers and to find the reason, if any, for such breakage. This is particularly useful in the case of taps and drills.

All drawers in tool-room benches slide clear through and open from both sides, so that if a man is looking in the top drawer on one side, all the other drawers can be reached from the other side without disturbing the first man. The tools are kept on inclined shelves, which is a common and yet a good way in most cases.

ASSEMBLING SCREW MACHINES.

As many jobs require a drill or drills, counter-bore and taps for bolt or stud holes, they have arranged these in sets as shown in Fig. 1. The block is 5 or 6 inches long by 3 inches deep, and holds the complete set needed for such cases. The pin in the center holds the tap wrench, hole 1 the small drill for tap; 2, the large drill for body of bolt; 3, 4 and 5, the three taps, while 6 and 7 hold the two counter-bores, one for each size of drill. These blocks are numbered as shown, are and given out on one check.

A tap which was designed to eliminate the errors in pitch due to change of steel while hardening, is made as follows, and is said to give very satisfactory results. The tap blank is turned up and chased as usual, the thread in this case (about 1½ inches in diameter) being probably 5 inches long. The flutes of the tap are only milled in 1¼ inches and the tap hardened for this distance only. All the distortion due to heating and cooling must be practically confined to this distance, and is comparatively little. The tap being run in (as a sizer only), the full threads back of the cutting portion act as a guide and the tap cleans out the thread to conform to the pitch of the unhardened portion.

There is another device in use here which will be found of value in many shops that turn shafting or similar work to gauge. The adjustable gauge shown in Fig. 2 is a collar of close cast iron, made with an opening and three screws, as shown; two, A and B, for compressing it, and C for locking it at any desired point. This plan has the additional advantage that, should the hole be worn larger at one end than the other, the large end can be drawn together and brought to standard size. They also have a full line of standard gauges for reference.

There is a large line of bicycle machinery being made here which is decidedly interesting, but which cannot be adequately described in the space at our disposal.

The planing and scraping is all done on one floor, under the charge of one foreman, which has several points of advantage. The labor of scraping depends largely on the manner in which the piece has been planed, and the writer has seen work—rather thin, to be sure, but still thick enough to be done right—which would hardly lie still when it came off the planer; wasn't clamped down right. If this goes to another foreman he kicks—possibly swears a little—but it isn't as easy for him to reach the guilty party. Here the foreman can readily know who planes work "on the bias," and apply the proper remedy.

The pattern and drawing rooms are on the same floor, with simply a door between, which is another time-saver, as every draftsman knows. The drawing-room is a large light room, has plenty of shelf and drawer room, and is very convenient in every way.

They have a little kink for drying blue prints which is ingenious and saves time. Over the washing tank is a sort of closet, with double doors and racks, but no bottom. After being washed the prints are laid over round wooden rods (about an inch in diameter) and slid into the rack so the surplus water drips into the tank. Near the wall and about a foot below where the bottom of the closet ought to be, is a Bunsen burner, a piece of quite heavy iron being interposed between the flame and the prints for the double purpose of keeping the dripping water out of the flame and the direct heat of the flame from the prints. With the doors closed, this

DRAWING ROOM.

closet becomes quite warm and dries the prints very quickly. (See page 349).

As the Garvin Machine Co. carry a large stock of new and second hand machinery, it might be supposed that some curios would be found, and this supposition was well founded, for Mr. H. M. Norris, who kindly showed the writer around the shop and pointed out the interesting details, had a gem of machine design all picked out for me to photograph, if it had been a good day.

The tool in question was an old slotter, which I was informed had been bought from the Ames Iron Works, of Oswego,

N. Y., where it had been used by the grandfather of the present Ames generation. It was built on the architectural plan, the column having evidently been moulded from one of the columns of the builder's house, after the addition of a sort of porch with a mansard roof, to support the upper end of the slotting ram. The base was in another style of architecture and ribbed so heavily that it might almost as well have been solid, while probably to add stability (?), the base had been narrowed in at the bottom until the top of the base was nearly a foot wider than the bottom.

* * *

"CENTRIFUGAL FORCE" OF BELTING.

ROBERT GRIMSHAW.

On page 221 of the March number, "M. E." gives the so-called "centrifugal" force of a belt making 7 000 feet per minute as 182 pounds per square inch of section, and thinks that 960 turns is too many for a 22-inch pulley, for that reason. There are plenty of dynamos running 1 200 turns, with 22-inch pulleys, and that is over 6 900 feet, which as far as lineal belt-speed goes, is near enough to 7 000 for all practical purposes, and in centrifugal force nearly 23 per cent. higher.

With 2 000 feet belt speed on pulleys of various diameters from one to three feet diameters, the following table shows the rotation, speeds required, and the proportionate centrifugal force *on the pulley rim:*

Pulley Diameter, Feet.	R P. M.	Comp. Centrifugal Force on Pulley Rim.
1.	637.	100.
1.25	510.	80.
1.5	425.	67.
1.75	364.	55.
2.	318.	50.
2.5	255.	41.
3.	218.	35.

If, as "M. E." says, the belt gets the same centrifugal force as the pulley rim, then the advantages of high belt-speed got by increased pulley diameter are apparent in the decreased centrifugal force.

A strip one inch wide and one inch long would at 0.85 pounds per square foot, weigh 0.0059 pounds, and if the so-called "centrifugal force" acted on it just as on the pulley rim, there would be at 960 turns of a 28-inch pulley a strain of

$$\frac{0.0059 \times 960 \times 960 \times 14}{244.4} = 311.5 \text{ pounds}$$

per inch of width;* but I doubt it.

The "centrifugal"† force (so-called instead of "tangential" force) of a belt running between two pulleys is perhaps not reckonable on the same basis as that on the pulley. In the case of the latter, the tendency of every particle in the rim is to fl off, not radially, but at a tangent to the rim at the place and time of breakage of the latter.

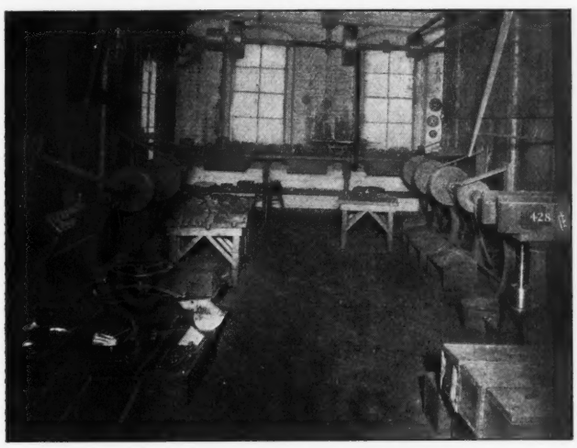
That is, if the pulley indicated by Fig. 1 be suddenly cut in the places A, B, C, D, etc., the pieces will fly in the directions of the arrows, *i. e.*, tangentially to their path at the time of separation. If the rim were of India rubber and were rotated too fast, it would tend to stretch before it broke. But suppose that instead of the rubber rim being rotated by the spokes or arms, it were driven by friction from an inelastic inner rim, as in Fig. 2, and then give the latter increasing rotation—velocity. As the speed increased we will admit that the rubber rim would tend to

* "Nystrom's Mechanics," page 450; formula

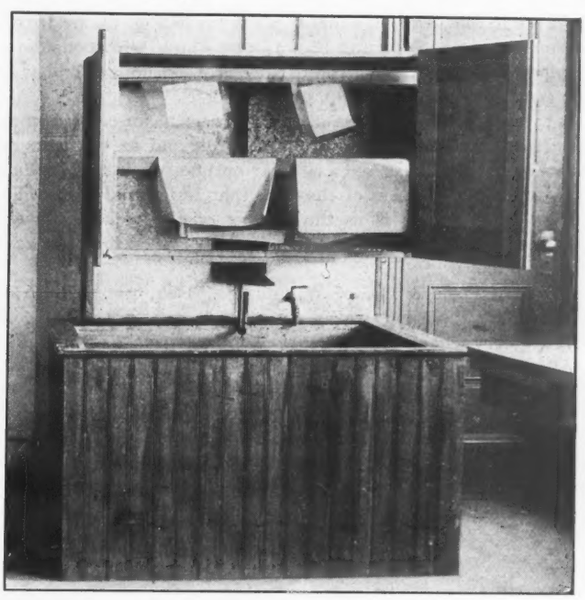
$$F_c = \frac{W R n^2}{2933}$$

when W = weight in pounds, R radius in feet, n revolutions per minute.

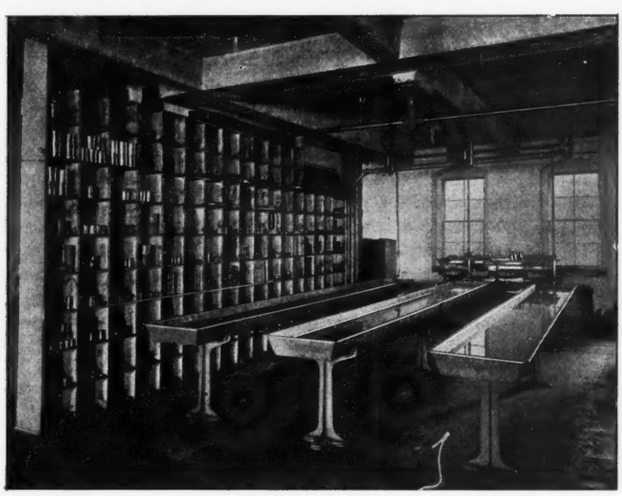
† The late Mr. John C. Trautwine, Sr., agreed with me that the term "centrifugal," here applied, was a misnomer.



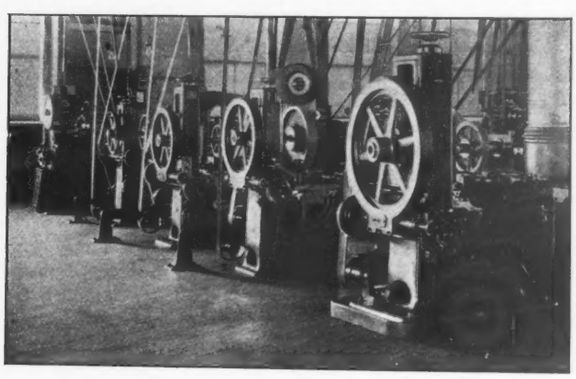
BUFFING ROOM.



CLOSET FOR DRYING BLUE PRINTS.



WASH ROOM.



GEAR CUTTING DEPARTMENT.

VIEWS IN THE GARVIN MACHINE COMPANY'S SHOP.—SEE PAGE 346.

expand; but this would bring it clear from the inelastic rim or felly, and when clear therefrom it would rotate only at the speed that it had when it left the felly; this speed tending to gradually diminish. But with decreased rotation-speed the rubber rim would contract, and that would bring it back on the inelastic felly, when it would get new impulse and increased speed, which would stretch and free it again. It would then slow up once more; the rim would next grip it anew, and so on *ad infinitum*. In fact I don't know what would become of the thing, and I leave it to your readers to get some fun out of.

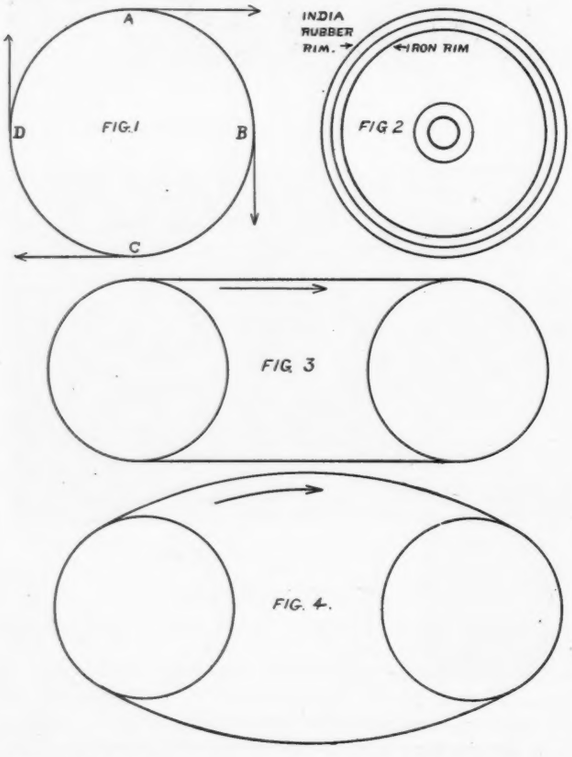
If so-called "centrifugal" force cut any ice (as the phrase goes) with belt-drive, we would find the belt outlined in Fig. 3 tend to assume the position shown in Fig. 4, if the pulley centers were approached to each other; and by bringing them close enough we could, if the friction was sufficient, at a certain speed get the belt into the shape shown in Fig. 5. Even with the pulleys in normal position, instead of there being two "sags" where the pulley axes were in the same horizontal plane (as in Fig. 6), we would get such outline as is seen in Fig. 7—one which, with considerable experience with belts at high speeds, I do not remember to have seen.

As 13 000 rotations per minute are quite usual for certain small belt-driven spindles in New England mills, and as the belts do not break nor try to assume a circular outline, we must conclude that, especially in view of the fact that tangential force (miscalled "centrifugal") is as the *square* of the rotation speed, there is a leak in the idea that this force works on the belts as it does on pulleys.

J. Morton Poole & Co., of Wilmington, Del., got as high as 30 000 (thirty thousand) turns per minute out of a small belt-driven emery wheel, some twenty years ago (more or less; ask Mr. Wm. T. Porter, of that firm). If the

$$\frac{W R n^2}{2933}$$

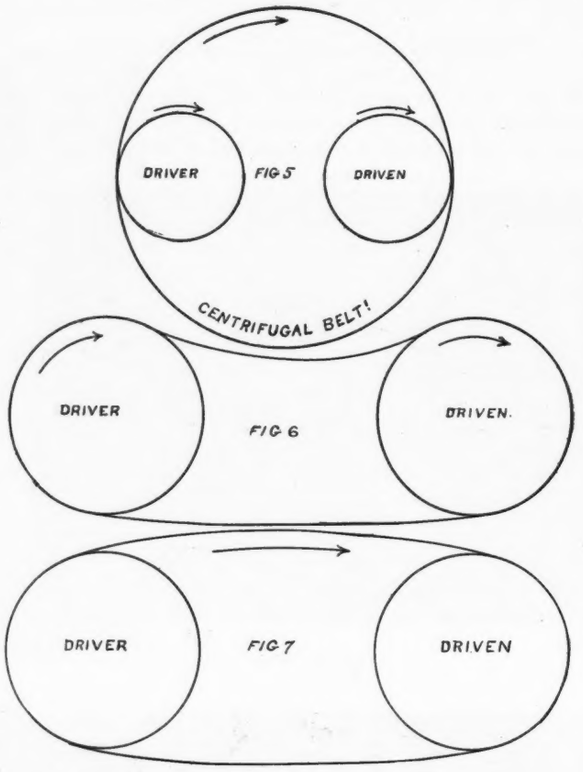
formula had been applied at the time to that belt, I think it would have proved a misfit.



The orthodox circular-saw speed in soft pine districts where logs are sawed by contract at so much per thousand feet, is 13 000 feet per minute at the rim. Six-foot saws being used, this gives 690 turns per minute. The pulleys are sometimes two feet in diameter and two feet face, and this gives 4 333 feet per minute. Such pulleys, however, are far too small for the work, and require "binders" to increase the arc of contact; and three-foot pulleys are better for the work, as giving more surface of contact.

To run a band-saw (which is a steel belt) the regulation 4 000 feet per minute on four-foot pulleys, calls for about 320 turns per minute. Now to get the same lineal speed out of it on eight-foot wheels calls for only 160 turns. The relative centrifugal forces on the two wheels are as $320 \times 320 \times 4$ to $160 \times 160 \times 8$, or as 409 600 to 204 800; just two to one in favor of the bigger wheel. So if centrifugal force is a bugbear in belt-drive, to be avoided, the larger the pulleys we use for a given band-saw speed, the better.

Further: a large pulley with a thin belt gives less centrifugal force, as the belt is lighter per square foot.



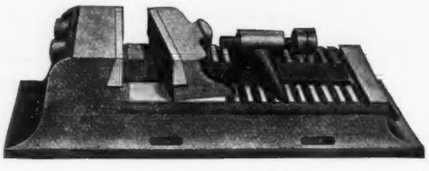
In many communications from belt users to the mechanical papers we find "suction" mentioned as a bugbear; and some suggest holes in the pulley face, others holes in the pulley rim, to do away with it. I don't take any stock in suction as a cause of loss of either speed or power in belt-drive, but merely mention it as an example of the ideas which people get hold of, or which get hold of people.

Incidentally I may remark that the strength of good belt leather is about 650 pounds per inch of width; when spliced and riveted, 325; when laced, 220 and upwards. "M. E.'s" 180 is not enough.

* * *

PLANER CHUCK AND DRILL PRESS VISE.

This vise is made in various sizes for planer and drill press work, and here are several advantages in the construction of this tool not contained in other vises for these purposes which are valuable and necessary features. Any work being chucked is given a slight downward movement, the under surface of the work always being on the same plane as the upper surface; the obvious advantage being that work when planed, shaped or drilled, may be depended on to be true with its under surface. An equal grip is given to the work even where it is taper. The loose jaw can be rapidly adjusted to various sizes of work. The slot running through center of vise allows the drill or cutter to pass through. For further particulars write the Massey Vise Company, 35 and 37 South Canal street, Chicago.



PLANER CHUCK AND DRILL PRESS VISE.

FROM ACTUAL PRACTICE.

"MILO."

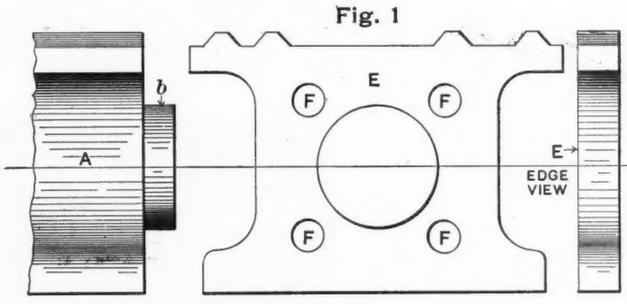
ONE METHOD OF MAKING JOINTED LATHE BEDS.

Here, in Hardscrabble, we have such a variety of work that when a man gets a chance to think he begins to wonder how this or that kind of a job is done in other shops, for he may have one like it himself some day. It was on such an occasion that Thoughtless walked over to his neighbor and said: "Max, when I was off on my vacation last summer I went into the shop where that lathe of mine was built, and I have been wondering ever since how in time they ever make such long lathe beds with the tools they have. Why, that lathe is nearly twice as long as any planer they have got in the shop, and I don't see how they ever managed to plane it. I have heard old fogies complain that the modern machinist was no good as compared with old-timers who had to work out such things as lathe beds from the rough casting with cold chisel and file, while a boy couldn't help getting good results with the planers and other improved machinery of to-day. I'll tell yer what, Max, I think it required as much skill to build that lathe with their tools, as it did to chip and file those old-timers that we hear so much about."

Max told him that they make such beds in two pieces and bolt them together. But in all the time that Thoughtless had run that lathe he had never noticed that there was a joint in it, and wouldn't believe it until Max wiped off the "ways" nice and clean and showed him the joint, and the bolts down inside the bed. Then, Thoughtless wanted to know how they could make them in two pieces and get such perfect results.

In the discussion that followed, a man was found who had seen the same thing done in a shop where he used to work, and probably in the same way, which is, as follows:

Fig. 1



SECTION THROUGH JOINT

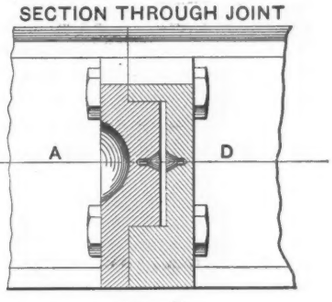


Fig. 2

The ends that are to be bolted together, are cast, as show in sketch, (Fig. 1). *A* having a circular projection, *b*, about six inches or more in diameter, which is turned to fit nicely into a corresponding recess in its mate *D*, which prevents any lateral motion between the two parts when brought together. To plane the two parts of a heavy lathe bed and fit the two ends together having the lathe work, planing and bolt holes all accurately correspond, requires some little thought and care, and the Maine Yankees that built the largest lathe in Hardscrabble, deserves credit for doing it so well that Thoughtless never noticed the joint that looked like a mark of a "scratch awl," in the months that he had been wondering how they could make it at all with their tools.

The first thing to do is to get a piece cast like *E*, which is just the same size and shape as the ends of the bed that are to be bolted together, and about an inch and a-half thick, with a hole in it corresponding to the one into which the projection *b* fits. This piece *E* is planed on both sides to a uniform thickness, then *D* is carefully centered and put in the lathe and the end faced off, leaving the recess rough. Next, *E* is clamped on to the end of *D* and four holes *FFFF* bored through both *E* and the end of *D*. These holes are carefully reamed, great care being taken to get them square with the end of the bed that was faced off in the lathe, because these same holes are the ones that will be used in bolting the two parts of the bed together. The seat for the nuts is finished off, and four bolts that fit perfectly to the holes just bored, are put through, and *D* and *E* are bolted together. *D*, with the piece *E* bolted to it, is put back into the lathe and the recess finished to size, boring through *E* at the same time. Without removing *E*, *D* is put on the planer and planed just as if it was one complete lathe bed, starting the chip at the end where *E* is bolted on so that it will have the larger mass of metal behind it for support and at the same time avoid the ragged edge at the joint were the two parts of the bed come together. A good sharp edge on *E* is also obtained to work from in planing *A*. When this half of the bed is planed, *E* is removed; *A* is centered and put in the lathe and the end faced off nice and square, *b* being carefully turned and fitted to the large hole in *E*, which is a perfect duplicate of the recess that it must fit into in *D*. Putting *E* on over *b*, the bolt holes are bored to correspond with those in *E* and the two are bolted together, care being taken to bolt the opposite side of *E* against *A*, from that which was bolted against *D*. Now we have got *A* ready to be planed, and beginning as before, at the end where *E* is bolted on it, is planed to correspond exactly to the outline of *E* which serves as a pattern.

In planing, one of the most important points is to get the planing exactly square with the ends faced off in the lathe, otherwise there will be a crook in the bed at the joint, although the outline of the two pieces may correspond exactly like the mitre in a picture frame, and the howl that will come from the fitters will be anything but pleasant to the man who did the planeing.

In making these sketches, I have made no effort to draw them to scale, intending them for illustrations only, Fig. 2 showing section through center of joint when done.

SETTING UP NEW MACHINERY IN THE HARDSCRABBLE SHOPS.

Business was picking up at the Wise Mfg. Co. and the superintendent bought a new lathe and a planer. The lathe came first, and was set up in short order by the foreman, in the foot-prints of our old lathe that had long since departed, leaving the driving pulleys in position on the line shaft all ready to belt from for the new one. It didn't take him long to get it into position, and bolt it down. The two old over-head belts were found in half the time a man in Nay & Co.'s shop would be looking around for an old file or a spike, to get a taper shank out of the drill press. By the time the two old belts were laced the vertical belt was on hand and was soon in running order. When it came to running the lathe carriage back and forth, it worked so hard that he loosened up the gibs, and everything was pronounced all right, then it was turned over to a young tramp machinist, with instructions to point the centers and make a couple of new ones ready for use. In working on the point of the center, the tool would duck and run under it. Tramp watched it duck two or three times and decided that the carriage wasn't gibbed down tight enough. But when he tightened the gibs enough to take up the lost motion he could hardly move it along, so he loosened up all the gibs and found that the carriage was rocking on two extremely opposite corners as if the bed was twisted. He then loosened up the feet of the lathe which improved it. By putting about $\frac{5}{16}$ of an inch under one foot it was level up where it should be and gave no more trouble in that direction. He had begun making the new centers from good cast steel that had never been annealed. They were on $\frac{3}{4}$ of an inch in diameter, but he was running the lathe with the back gears in, and taking a nice finishing chip when the boss came along. He noticed the back gears but started to walk away, then came back again, saying: "Oh tut, tut, tut, that will never do; back gears on that little stock and a light chip, too. Can't you speed that up a little?"

"How fast should it run?" asked the tramp.

"Take out the back gears, anyway," was the reply.

"But you are foreman, and have been in this business long enough to have some idea how many feet per minute is suitable for turning ordinary cast steel. How many feet per minute do you think a tool should stand cutting that stock?"

"About 16 feet per minute."

"But there is that little planer that you keep on one kind of

steel all the time. It only runs 12 feet per minute and the stock is all annealed, while I am turning this unannealed cast steel at 28 feet per minute with the back gears in and it is only ¼ of an inch in diameter. If you want me to run this lathe with the belt on the same step of the cone as its twin brother here turning the same size stock, you will have to put the same size pulley on the line shaft."

Tramp was requested to climb up and find out what size of pulley was wanted and stay to put them on during the noon hour, which he did.

Coming back from dinner about an hour later than usual, he found that the foreman had put the belt on the planer and that it was running. The superintendent saw it running and stopped to look at it as he passed, and the tramp did likewise.

"Well, what is the matter with that," asked the boss; "doesn't that suit you, either?"

"Yes, it suits me so long as I haven't got to run it, but I think it would be better if it had a slow cut and quick return motion instead of quick cut and slow return, as you have got it."

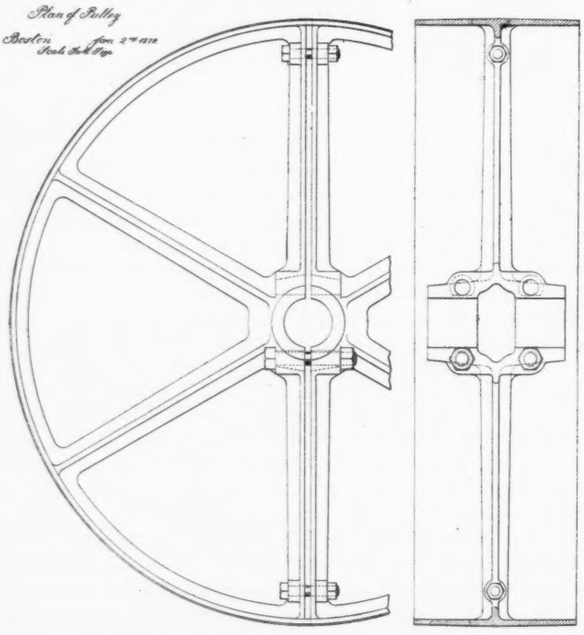
The superintendent smiled and walked away as the foreman muttered: "Well, I'll be danged if I see how I got that belted up wrong; I put the belts on just the same as they are on that other one. Get up there, Tramp, and fix it while I get some stock and tools for you to start it up on the regular work.

* * *

THE SPLIT PULLEY PATENT.

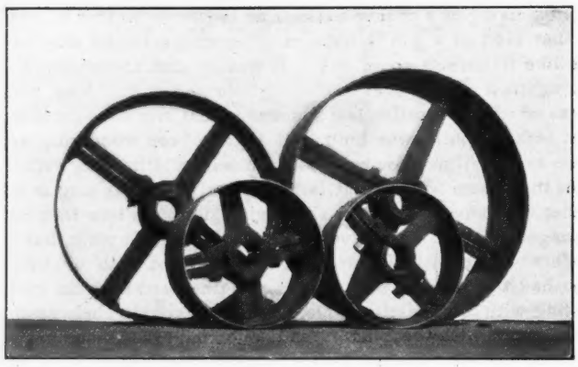
In the December issue we noted the decision in favor of the Dodge Manufacturing Co. in their suit against the Chattanooga Co. for infringement of their split pulley patent. The Dodge Company evidently did not court a rehearing, as they made very favorable terms with the defeated company on their agreeing not to appeal nor to rebuild their factory, which had been burned.

The next move was to patch up an agreement with one of their worst rivals, the Reeves Co., and the two are now trying to make ing life a burden to other manufacturers, some of whom have surrendered, while others are continuing the fight against the Dodge Co. Recently this company has brought suit against the customers of the Saginaw Manufacturing Co., who make the



Gilbert split pulley, and are attempting to force them to use the Dodge make. These suits seem to be half-hearted affairs, and intended more as a bluff than anything else, since no preliminary injunctions have been asked for, and according to good authority as well as common sense, the Gilbert pulley in no way infringes the claim of the Dodge people, even assuming that the decision referred to is correct. In order to throw some light on this controversy we have taken the trouble to dig out some old pulleys, whose existence should have considerable bearing on the disputed points.

The above line cut was reproduced direct from the tracing of a drawing made by the American Tool and Machine Co., Boston, Mass., dated January 2d, 1872, which was completed before that date, and in accordance with which that company has been making split iron clamp pulleys for the past twenty-five years. These pulleys were secured to the shaft by the clamping bolts

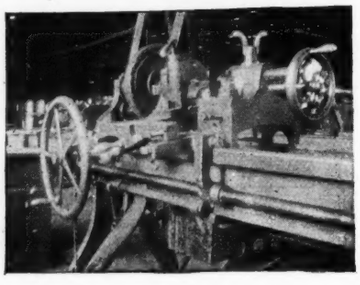


only, and not provided with either keyway or set screw by the makers. The above half-tone illustration is from photographs taken by the writer on May 26, at the works of the Billings & Spencer Co., Hartford, Conn., and the pulleys have been running in that shop ever since the oldest workman can remember, which carries them back about twenty-five years and probably longer. These are but two of numerous examples of the use of split iron clamp pulleys in New England for more than twenty-five years past, but they are sufficient to show that no one can lawfully claim any monopoly of the split pulley business at this late day.

* * *

AN OLD LATHE.

This is another relic of the old lathes used years ago, probably in the early '50s, and was found several months ago in Nashua, N. H. The back or dead spindle is moved by the screw beneath it, instead of inside of it, as at present. The connection with the lead screw is very prominent in the foreground, and does not impress one as a model of stiffness. The antiquity of the "rise and fall" carriage is seen here, the familiar weight being shown underneath. There are other interesting features revealed by inspection.



* * *

THE firm of Sinclair & Hill has been dissolved by mutual consent, and all interests in *Locomotive Engineering* have been transferred to the Angus Sinclair Co. Mr. John A. Hill has secured control of the *American Machinist*, and will devote all his time to the management of that publication.

* * *

NEW PATTERNS OF SAND-SIFTING MACHINERY.

GEORGE D. RICE.

The writer has recently been engaged in getting out several new styles of sand-sifting machinery for foundry use, and thinking that some of the types may be useful for your readers to adopt (they are not patented), I herewith hand you drawings and descriptions of the same. In Fig. 1 is a type of sand-sifter which I erected at small cost, using odds and ends from about the shop and have found the device to be very serviceable. The cradle was one formerly used on a sifter which had been cast aside. I put the toothed plate-pieces B, B on either side, and arranged for upright half-gears A, A, to mesh in with the cogs, as shown. The entire weight of the cradle is upon this geared motion. Now it is only necessary to employ a movement that will cause the sand to sift, and this is done by putting a connecting rod D between the shafts of the half-gears and the stud on the wheel E. This wheel is driven by the belt and the over and over motion communicated to the half-gear shafts, and the cradle is rocked in a manner that differs from the ordinary way, and at the same

time gives the sand a thorough sifting through the screen bottom, whence it falls out at C, striking upon the sides F, F, and going to the floor through G.

AN EIGHTH-MOTION SIFTER.

The plans for building the novel sifter shown in Fig. 2, were furnished me by a man long skilled in foundry work. He is pleased to term the arrangement an eighth motion machine, as the cradle shifts on a level base to the extent of one-eighth its circumference.

I first built a base B, B, and upon this base put a race-way for a series of balls, so as to run the machine on the ball-bearing plan. The race-way on the base and the ball casing on the bottom of the cradle, are V-grooved as may be seen in section at A, A. A strip of toothed iron casting is set screwed to the cradle at C and the gear D fixed up to engage with it as shown. An eccentric cam at F is keyed on the driving shaft, and the latter run by the belt. This eccentric cam operates the arm which is connected with the stud at E, and as the latter is on the shaft with the gear

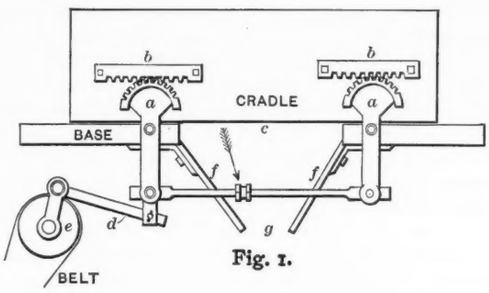


Fig. 1.

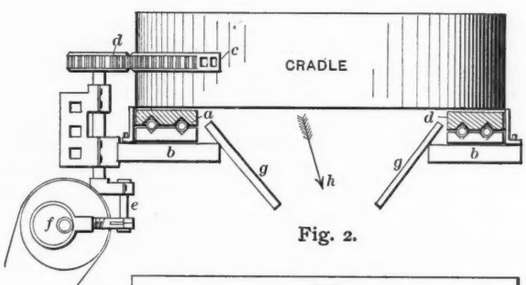


Fig. 2.

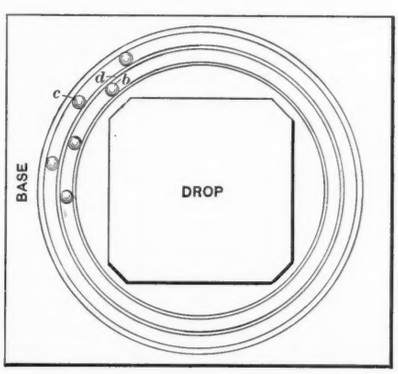


Fig. 3.

D, the necessary motion is given to the cradle, which is a circular movement one-eighth each way, the shifting resulting in the sifting of the sand through the wire screen bottom, through H, and guided by the slide pieces G, G. A top view of the base and ball race-way, showing the balls C, B and ridge A, is shown in Fig. 3. This race-way is cast iron, the grooves smoothed and polished.

Attention is next called to the design of sand-sifter presented in Fig. 4, in which the feature of note is the method of introducing the sand in a cylindrical cradle. The cradle is a wire-covered cylinder, provided with the ribs C, C, and set in end bearings A, A, as shown. The bearings are of the ball system, and the arrangement of the balls and cones is shown at B, the box being shown in cut-off.

The reason that I use ball-bearings in sand-sifting machinery is because power is saved owing to reduced friction, and the motion resulting is peculiarly adaptable to a machine of the nature of a sand-sifter. The mode of introducing the sand into the cylinder is through the tin or sheet iron D, the sand falling from above and reaching the union where it is to enter the cylinder pipe E, a blast of air from a blow-pipe F, sends it forward into the machine, where it is sifted, falling out through the wire at the bottom into receptacles. An ordinary blower serves to furnish the air to the blow-pipe, in which pipe should be a check valve. The pipe E is provided with sleeves at the bearing, so that it serves to substitute a shaft for that end of the cylinder.

The forms of sifters from Figs. 5 to 7 are given because they are odd in design. The writer tried them all, making the cradles in each case with wooden ends, and covering the rib work with the regulation sand-sifting wire. The bearings are flanged pipes, as marked A, B and C. Fig. 5 is a perfectly square pattern; B is three-sided and seven oblong. These are turned in bearings set up on the plan adopted in Fig. 4. In Fig. 8 is a somewhat complicated yet efficient sifter for getting three grades of sand, fine, medium and coarse. The view shows the cylinders in section. The sand is admitted to the central cylinder A from the feed pipe, which cylinder is covered with coarse wire, permitting the

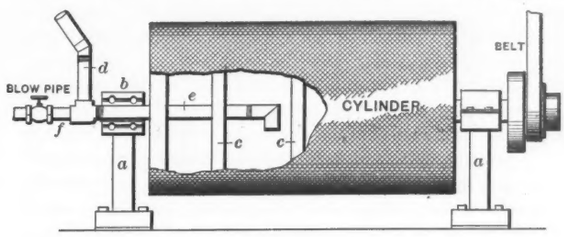


Fig. 4

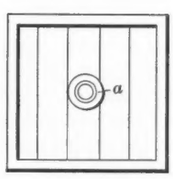


Fig. 5

Fig. 6

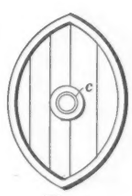


Fig. 7

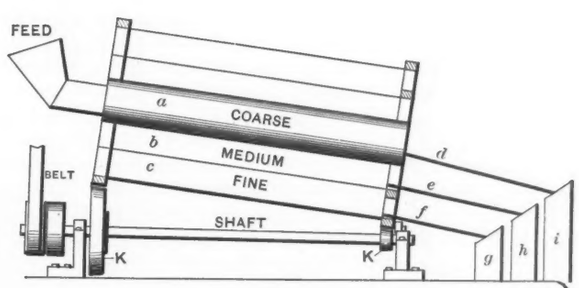


Fig. 8

required grade of sand to pass through to the second cylinder B, which is covered with medium wire, from whence the next grade of sand passes to the final cylinder C, the latter being covered with fine wire. The three cylinders being on a slant, the rejects are passed out at the lower ends on to the planes D, E and F, and into the respective wooden shutes G, H and I. The body of the cylinder is revolved upon the wooden friction wheels K, K.

Foundrymen are at liberty to use any of the above designs.

* * *

THE File Manufacturers' Association of the United States held a meeting at the Astor House on June 16th, and prepared a new price list to take effect July 1st, 1897. The new list advances prices about 10 per cent., and manufacturers claim that this affords them only a living profit, as they say that files lately have been selling for less than the cost of production. The following officers were elected to serve for the ensuing year: E. G. Heller, president; Henry Barnett, vice-president; C. C. Clarke, secretary and treasurer.

MANUAL TRAINING SCHOOLS.

WM. O. WEBBER.

It is pretty generally admitted that a common school education is requisite for those who are to be citizens and as fitting the recipient thereof to more readily understand our laws and the reasons therefore. I would suggest, however, that this does not constitute the whole duty of the State to the individual at large, but that it should also give such individual some instruction, if even of an elementary nature, but which such individual can, if not earn a competence, at least be able to secure the necessities of life and therefore preclude as much as possible the chances of his becoming a pauper and an object of public charity.

If, therefore, the reason is sound for compelling an education which only benefits society at public expense, why should it not be a still greater duty to compel the learning of a handicraft which should produce positive results in benefiting mankind and promoting public welfare.

The purpose of public education at public expense is to fit for good citizenship. Good citizenship means qualifications to discharge the duties of a citizen in the sphere of life to which one is adapted by natural abilities.

A great many of our communities take this stand with their criminal classes, and as soon as a person is committed to State prison for three or five years or longer, he is immediately set at work at a trade as a means of reforming (?) him. I would submit whether it would not be much better to compel this learning of a trade before the person has so offended against the laws of the community that it is necessary to lock him up in State prison.

In a report recently given by Mr. Brockway, superintendent of the State Reformatory at Elmira, N. Y., he said: "There are altogether, in the reformatory, about fourteen hundred felons. The average age at committal is from sixteen to thirty years, and the average period of detention is twenty-four months. The discharges each year number four hundred, and, with exceptions, they are sent out first on parole; and for each man thus paroled we have for some years found places where he could work and support himself, if so disposed, at the trade which he had learned in our work shops." He said: "All the leading trades are taught there, not perfectly in all cases, but so as to give a man a self-supporting business. Of all the men committed, not more than two per cent. have any trade when they are so committed."

It seems that we are much behind other countries in recognizing the value and possibilities of manual training, not only as a means of decreasing the number of our criminal class, but also for other practical and beneficial results, which will be alluded to. Our national system of education must not be permitted to drift to the literary side alone, as it is doing in the United States. The character of the teaching in America tends toward creating a distaste for manual labor. The American boy would cease to regard manual labor as drudgery if his mind and hands were trained industriously together through his school period. An opportunity should be given him to learn to manufacture something, as well as to conjugate Greek verbs, etc.

The public schools should give some measure of instruction that shall fit the pupil for the best discharge of the practical duties of some specific trade, not necessarily the one the pupil will ultimately enter, but one to which he can always turn as a means of livelihood.

That this is not a new proposition, is proven by the fact that the Hebrews, for a period nearly as far back as their history goes, required all of their young men to learn a trade.

France has had an organized system since the time of the First Empire, and Germany has done more. Even China has a system of this kind, although not so clearly defined and different in character from other literary training.

A clipping from a daily paper, the *Boston Herald*, Jan. 31, 1897, from which I quote the following, says: "The great progress that the Germans have made of late years in manufacturing is believed to be entirely attributable to the fact that quite fifty years ago they entered upon the work we are now beginning. They have built up a great corps of thoroughly instructed artisans, who are now showing their skill in producing goods which enter into the world's market, and go a long way toward driving the goods produced by the people of other nations out of the market. Realizing the advantages which this thorough training secures, the English have of late years attempted to make good their deficiencies in this respect, and have gone a long way toward doing this. We, on the other hand, have been the last of the great manufacturing nations to realize the need of this class of training. It is a work which implies large original outlays, but the only way in which really great enterprises succeed is by not counting the cost. If something has to be done, no expense can be too great for its accomplishment, and in the competition—both foreign and domestic, that manufacture has to meet—we, in New England, cannot afford to lag helplessly in the rear."

Another point which I wish to bring distinctly into prominence, is the value of a handicraft and technical training on the mental capacity. We are all willing to recognize a much due homage to the general handiness, as we call it, of the sailor man. The most illiterate and otherwise ignorant seaman, is valuable to us in many ways, even on shore, because he has learned to be prompt, without questioning the reason or wherefore of the order given him. He has learned to control himself, to be quick-headed under moments of intense strain and excitement and because of his training and the knowledge that he knows how to do some things superlatively well, gives him a confidence in himself which is invaluable. Also the habits of steady application and persistent effort continued in one direction to accomplish a desired result, gives a person a confidence in the beneficial result of such persistent application which he can obtain in no other way.

We are often told that a drop of water continually falling in the same spot will wear away a stone. If a person has learned by actual experience that by continued application he can file into a bar of two inch iron, or can reduce to the clearness of a mirror the surface of a rough piece of granite, things which would otherwise seem insurmountable obstacles to him, become merely a matter of time and application.

Then, again, in addition to all of these points, the confidence that the person so equipped with a manual training has, in a provision for the future, gives him strength and courage to push himself forward in his chosen calling beyond a point where he would otherwise fall back and consider himself a failure, and it is often found that just at this point success comes.

Again, the practical man who knows how to do things well, is always the man sought after, for there is always work for him to do and a place for him to do it in, and he is in every way a superior citizen, to the man who is either a "Jack of all trades," or who has a technical knowledge of how things should be done, but could not, to save his own life, do any of them.

As Horace Mann was far in advance of the world of his day, a half a century ago, when he shook the dry bones of the public educational system of Massachusetts, so that the world has since far out-grown Horace Mann. After him came Herbert Spencer and the lamented Huxley, in England, to expose and reform the absurd anachronism, then called a liberal education there, which taught the pupil everything except the thing which it was necessary for the nineteenth century man and woman to know. t length we find ourselves face to face with the great practical truth, that education has become the necessary basis of the full development of the industrial productivity of a nation. We should now attempt to estimate the significance, and to measure the results of this newly discovered truth; to treat of industrial education in relation to industry, and to the individual engaged in industry.

Many men have grave doubts as to the propriety of the employment of public funds for what is known as the higher or secondary education of the people. It seems to me that upon consideration there can arise no doubts whatever, either as to the right or duty of the State to supply the facilities wherewith every citizen may learn how he can earn his living to the best advantage. The true function of public education is to fit the masses for the life-work directly before them.

Early manufacturers had a very simple problem, as their manufacturing was of the plainest kind. The boys and girls soon learned all that it was necessary for them to know, as their education consisted chiefly of the three R's; native mother-wit and the "rule of the thumb" did the rest. The primitive industry of that day has grown into a complex, exact, scientific undertaking.

People have gotten into the habit of thinking that because a man operates machinery that he, therefore, must be called an "operator," and can no longer be a worker of industrial art.

I am wholly in accord with the popular impression that the

American artisan, in average intelligence, in ingenuity, in physical energy, has not his match; but, in the technical education which underlies all modern manufacturing, the artisan of nearly every other manufacturing nation is his superior.

Those who have travelled abroad have probably noticed in every considerable textile center of France, Germany, Holland, Belgium, Switzerland and England, the local technical schools. They are generally large and handsome buildings in the center of the town. Near to the schools—and often a part of them—will be found an industrial art museum. As a distinguished German visitor to this country once put it: "Your finest workshops are those in which you make your machines and your fabrics; our finest workshops are those in which we make our men."

Machinery considered apart from the human agency behind it, tends to reduce the whole world to a level plane. The only way we can save this competition is by supplying men to run the machines, who have superior intelligence, and this intelligence must be trained in the art and technique of manufacture. The knowledge of this fact is the reason why they have founded so many of these technical schools abroad. They are not in advance of us there in the mechanism of manufacture, but they are far in advance of us in the training of their artisans.

Such a technical training is not to be obtained in a mill or workshop. Training in a mill or other factory, is necessarily confined to a single room in which each person finds himself placed. Hence arises the need of a manual training or industrial school, and until the community furnishes such opportunities and facilities, they will have to bear the consequences that follow their absence.

To the man who enters factory life as a treadmill, the prospects are dreadful, but to the man who enters it competent to master it, it offers very bright opportunities.

The question often arises that this sort of education is only intended for mill superintendents and foremen, as it is not necessary for mill operatives to have such knowledge, and that there are not positions of responsibility enough to supply all of the wants if every artisan is to be industrially trained. I say that were more men industrially trained, work would be better done in factories and the owners would find that their material would be better produced, their costs lowered and their profits made larger.

Further than this, all such manual training of this kind should be under state, municipal or corporative supervision, so that uniformity of method would make it available and uniformly applicable to all seekers.

I do not mean by this method to detract at all from the work now being done by our technical schools and colleges, but they are for the higher branches and are not available for the masses. There are lots of good foremen and superintendents spoiled by our technical schools. There is now and always will be, a great demand for foremen and superintendents who have the practical knowledge, the habits of obedience and control, and the knowledge of the value of persistent application, which can be gained only by learning a handicraft.

The requirements of all technical schools and colleges should be much higher than they are at the present time, so that only those who have the previous education and mental capacity necessary to fit them for a professional life, should be capable of gain ing admission thereto.

There are many young men entering these schools who are not able and have not the mental capacity of graduating therefrom, who otherwise could, in the manner I have described above, make superlatively good men in subordinate positions, but who thereby become dissatisfied with such positions and make very poor professional men in consequence.

It is said that there is no school equal to the shop for industrial education. In a sense this is true, but in a very limited sense. As modern industry is carried on, no young man can obtain complete knowledge of the great industrial occupations from his daily experience. The best workman is the one who combines theoretical understanding of his trade with practical knowledge and skill. The shop supplies the latter; it teaches how, it does not teach why. It does not, therefore, teach hand and brain to work together to the best advantage.

Let due credit be given, however, for some notable new departures in the direction of industrial training. For instance, there is a well organized manual training course taught in the Fall River High School, in addition to the other courses. In a city like the above, where there are hundreds of young men whose life work will be to manufacture cotton, this is of incalculable benefit.

The Lowell Textile School, a very fine technical institution, was opened at Lowell on January 30, 1897. This school is equipped with first-class machinery, which is operated with the same method and perfection of a well disciplined mill. This school is a model, and it is to be hoped that other cities will soon follow the example set by the city of Lowell.

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

39. H. G. S. asks: Some claim that a long chain on a bicycle makes it pull easier than a short one. Is there anything in a longer chain? *A*. With the same size sprockets, the longer chain (that is longer distance between centers of sprockets) is the more objectionable for several reasons. Being longer it weighs more, contains more links, which means more joints and more opportunity for stretch. The belt similie will not answer because this is a positive drive, and the slack also comes on the lower side, which is not good practice in belting. With the large sprockets (both front and back) the longer chain is not such an objection, for while still containing the extra weight, joints, etc., these are offset by the reduced strain on the chain due to the larger sprockets, which are in reality longer levers. The large sprockets probably run easier on account of requiring less bend or movement of the chain link in passing around it. Always consider such questions as simple mechanical problems and don't be misled by the fairy tale of an agent, who generally knows little of bicycling construction besides the "talking points" to be found in the various catalogs.

40. A. L. T. writes: One of the shop men contends that it does not weaken a strap or rod end to ream out the hole for a larger bolt, providing the bolt *fills* the holes. It seems to me it must, but of course the hole is filled and the sides supported. What do you think about it? *A*. The pin prevents deformation or flattening of the hole under strain, but by no means replaces

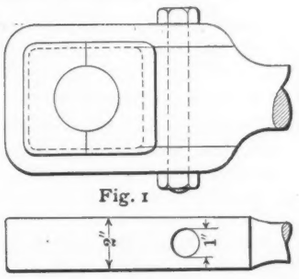


Fig. 1

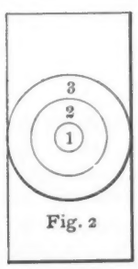


Fig. 2

the strength removed by reaming out the material of the strap and rod end. Take the case shown in the sketch herewith. The enlarged view in Fig. 2 shows three holes through the strap, holes 1, 2 and 3. Ask your shop-mate if he thinks hole 3 would weaken the strap if the bolt *filled* the hole? In thinking over problems of this kind it is well to imagine extreme cases, so as to be sure we are not being misled by appearances.

41. F. B. writes: Suppose we have a worm fixed to pull a certain weight, I wish to know if it will make any difference by taking the thrust at one end or at both ends in regard to friction. My opinion is, there will not be any more friction by taking thrust at both ends than there will be by taking it at one end. *A*. We do not see how you can very well take the thrust on both ends of a worm, as ordinarily constructed, if the thrust is all one way, as we presume it is. Of course a collar can be used to help take the thrust on the other end, but unless very nicely adjusted, one end will take, practically, all the strain. We should advise consulting some of the makers of thrust bearings if the work to be done is heavy. 2. Will there be more friction by using large collars to take the thrust, than by using small ones? *A*. When a very large collar is used the friction is increased, due to the increased velocity of the outer portion of the collar. It is advisable to turn a number of comparatively shallow grooves into the shaft so as to divide the work between several rings, as is used on steam ship thrust bearings.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

SQUARING NUMBERS.

If your friend the arithmetician would like to square two numbers in a shorter way than his, I think I can tell him how to do it. Take the first problem to square 16; if he will take the lower six (6), add it to the upper 16, making 22, then multiply this by the 10 that is left, making 220, then square the 6 = 36, which was taken away, add to the 220, 36, making 256 = 16^2; also take away 87 and add to the top line 7, making 94, multiply by 80, making 7 520, add 72 = 49 and we have 7 569 as the amount. I think this rule is shorter than his and much easier. I have used it for many years and find it very useful. C. HELTOOROM.

[This is simply another way of using the same principle as described in the June issue. Mr. H. uses the "next lower *tens* instead of the next higher *tens*."—ED.]

LIFTING CAMS.

In reply to a query regarding the lifting cam on page 246 of the April number.

I will take up the points of the enclosed letter as they occur. First your correspondent makes the error of scaling from the Fig. 9 as given in the issue of April, and finds it ¾ inch instead of 1½ inches, as called for in the text; but the drawing is made to half scale. Again he mistakes the reading when he says that in one place the lift reads as 1½ inches and in another 3 inches. The 3 inches reads somewhat ambiguously, but is meant to refer to the *entire* throw of the eccentric, and the lift is in action only during one-half of the throw, the exhaust cam working during the remaining half. The trouble he experiences with the tracing comes, I fear, from a feeling on his part that he must locate the points of the cam curve on the lines A, B, C, etc. He will have no trouble if, after making the tracing, Fig. 10, and placing it so that *x m* falls on X M, he draws the line A of indefinite length in both directions, then following the directions, have *x n* coincide with X N and draw the line B of indefinite length. When he has finished the series of lines into which the lift is divided, he will find that they enclose a curve which is the required cam-curve. Unfortunately the letters *x* and *m* in Fig. 10 have been smashed in printing. Again he asks how the irregular lines A, B, C, D, etc., in Fig. 8, are found. I think he meant to ask regarding the irregular lines A, *b*, *c*, *d*, etc., as the former is the problem explained in the text. The lines A, *b*, *c*, *d* etc., are, for the sake of the problem, taken arbitrarily, and represent any irregular path that a follower may, by the necessities of the machine, be required to move in.

I trust that this explanation is plain and will satisfy your correspondent. LOUIS ROUILLION.

A SHORTER CUT IN CUBE ROOT.

In the April issue R. E. Marks explained to you "a short cut in cube root," but, I think, if you are going to cut short at all, the quicker you cut the better, and to show that such a thing can be done, and the advantages to be derived by those who wish to use it, I do hereby take the opportunity of showing the method. It is all a matter of method, and the method that proves the simplest is the best. A comparison of the following methods will prove, without a doubt, that "a shorter cut in cube root" saves the most time, and, or as secondary consideration, a separate piece of paper that is necessary in most cases to do the multiplying on, in order to get the first correction, as shown in first method; and wherein lies the secret of this saving, that it is so simple the example can be followed mentally and written down just as rapidly as your gift in figures will allow you.

Aside from explaining that after squaring the first number of the root and multiplying it by 300 for a trial devisor, and the trial figure annexed to the root. To thrice the former part of the root annex the trial figure, as shown, and multiply the result by that figure; that the trial divisor for the next division is found by bringing down the square of the trial figure and adding the three enclosed lines to which two ciphers are annexed. I think nothing more need be said, as the following example will speak for itself.

There is a short cut in square root also, but maybe you are all aware of it, so I will not waste the time and space showing it.

A SHORT CUT IN CUBE ROOT.

		905 634 421 875	9 675
		729	
		176 634	
$9^2 \times 300 =$	24 300		
$9 \times 6 \times 30 =$	1 620		
$6^2 =$	36		
	25 956	155 736	
$6^2 =$	36		
	27 64800	20 898 421	
$96 \times 7 \times 30 =$	20 160		
$7^2 =$	49		
	2 785 009	19 495 063	
$7^2 =$	49		
	280 526 700	1 403 358 875	
$967 \times 5 \times 30 =$	145 050		
$5^2 =$	25		
	280 671 775	1 403 358 875	

A SHORTER CUT IN CUBE ROOT.

		905 634 421 875	9 675
		729	
		176 634	
$9^2 \times 300 =$	24 300		
$276 \times 6 =$	1 656		
$6^2 =$	25 956	155 736	
	36		
	2 764 800	20 898 421	
$288\ 7 \times 7 =$	20 209		
$7^2 =$	2 785 009	19 495 063	
	49		
	280 526 700	1 403 358 875	
$2901\ 5 \times 5 =$	145 075		
	280 671 775	1 403 358 875	

PORT HURON, Mich. WALTER F. HOLLIN.

* * *

JOHN WEDDERBURN & CO.

THE last paragraph of a long interview with Mr. John Wedderburn, in *Printers' Ink*, says:

"The firm of John Wedderburn & Co. have recently built a large five-story addition in the rear of their present offices, and a few days ago leased the big four-story building adjoining. The firm's private offices are sumptuously furnished in immense leather pieces, and prosperity is apparent in every direction the eye is turned."

This shows that there are still plenty of people who think they have ideas to patent and who are attracted by the premiums and other chromos offered by this firm. How many of those who have helped buy these "sumptuous furnishings" have "immense leather pieces" in their own houses as a result of their patents?

In the same paper is an advertisement of John L. Ray, of Gaylesville, Ala., who will pay 10 per cent of face value for notes of John Wedderburn & Co.

* * *

THE John M. Rogers Boat, Gauge and Drill Works, Gloucester City, N. J., have just published a very handy little booklet containing a variety of useful and practical information for the shop, which every tool-maker should get a copy of, especially as it is sent free by the above firm.

LIGHT SHEET METAL STAMPING, and small articles in that line produced at bottom prices. Write for estimate.
tf FRANK WHEELER & SON, Meriden, Conn.

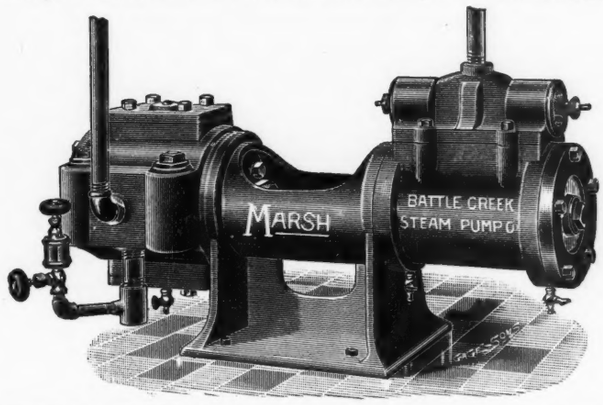
"HOW TO BUILD A STEAM ENGINE." "BLUE-PRINTS.—The Design and Construction of Modern Steam Engines." Parts 1 to 7 now ready for delivery. Price 30 cents for each part, with working drawings and full description on same. Send 10 cents for sample; stamps taken. Published monthly. tf
THEO. F. SCHEFFLER, JR., 943 East 21st Street, Erie, Pa.

FOR SALE.—Blue Prints of the working drawings of plain slide valve stationary engines, in sizes from 1 to 40 HP. The latest and best, at a reasonable price.
5t 4-1 OTTO E. EVANS, York, Neb.

POINTERS ON PUMPS.—VII.

We are building a line of direct-acting Air Compressors of an improved type, and have been most successful in introducing machines so perfectly adapted to the work, as to have met the approval and indorsement of the most skeptical.

The steam cylinders and valve motion are identical with the regular line of Marsh Pumps, and need no further mention here than that the self-governing steam valve is admirably adapted to the requirements of compression work, the piston load being always variable and of the cumulative order, in which the initial



pressure is nothing, increasing to slightly above reservoir pressure at the end of the stroke. These conditions are fully met by the automatic governing feature of the admission valve, which operates to equalize the pressure in the steam cylinder to meet the constantly varying resistance of the air, and therefore combining greatest economy in the use of steam with most efficient work.

In operation, these compressors are absolutely noiseless. The piston has a smooth and easy motion, and travels close up to the heads of the air cylinder, thus reducing clearance to a minimum.

The pistons are especially designed, combining strength, lightness and durability. The piston rods are of Tobin bronze; will not corrode or tarnish.

The air valves and seats are of phosphor bronze, and are placed so close to the piston bore that valve port clearance is almost entirely eliminated.

The air piston is provided with patent metallic expansion rings, which accurately fit the cylinder bore and require no attention.

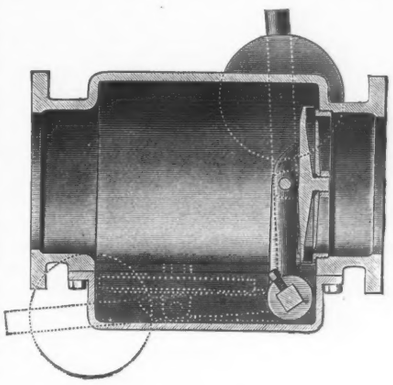
Cylinder valve and chest head caps, stuffing boxes, etc., are all polished bronze; in fact, the very best of both material and workmanship are used throughout.

These compressors are now made in twenty-four sizes, with steam cylinders from 4" to 12" in diameter, and air cylinders from 2½ to 18 inches. They are provided either with or without our improved water jacket, in which cold water is circulated twice around the cylinder before discharging.

THE BATTLE CREEK STEAM PUMP CO , Battle Creek, Mich.—*Adv.*

BACK PRESSURE VALVE.

This valve has just been taken up by Jenkins Brothers, 71 John street, New York, and is said to contain several features not found on any other valve on the market. It is noiseless and free from complicated attachments. The area is equal to that of pipe to which it is attached; it has no dash pots, springs, guides or complicated levers. It never sticks and can be placed in any position. The valve can be removed from passages without taking valve apart, by being swung up out of the way, as shown, so that it can be thrown out of use at will, by simply throwing the lever to the desired position. It has a perfectly straight-way valve, and the flat seat is an advantage which engineers will appreciate.



* * *

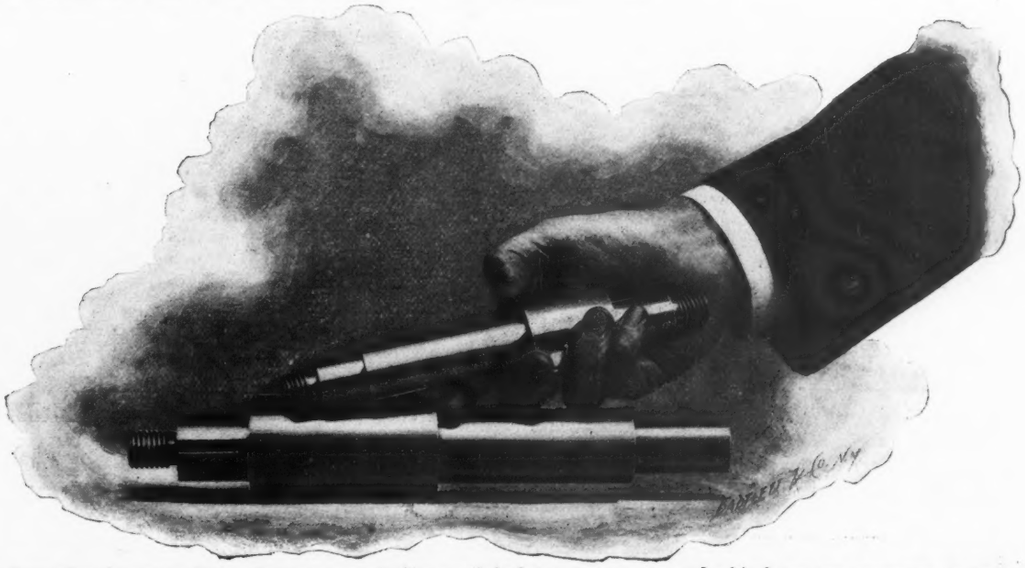
THE PAINT FOR 1897.

The finger of science points to graphite paint as the paint of the future for the protection of all exposed iron and metal work. Prof.

See preceding issues of MACHINERY for detailed descriptions.

A New Lathe System—VI.

The work shown below is the product of our 2 x 24 Flat Turret Lathe with Automatic Die Outfit, which gives the highest efficiency on such work. It turns out all diameters up to 2 inches and all lengths up to 24 inches, and cuts all U. S. Standard screws from ⅜ to 1¼, inclusive, by sixteenths.



If you have three or more lathes turning out similar work in lots of six to ten of a kind, we can save you 50 to 80 per cent. on the cost. Our method of demonstrating the saving makes it possible to know just what the machine will accomplish in each shop, and places no responsibility on the people giving us an opportunity to make the demonstration further than that they agree to accept and pay for the machine as per quotation, if such a saving is proven. Where it is not practicable to visit a plant we can furnish estimates from samples of the work or sketches.

JONES & LAMSON MACHINE CO., SPRINGFIELD, VERMONT, U. S. A.

FOREIGN REPRESENTATIVES—HENRY KELLEY & Co., 26 Pall Mall, Manchester, England.
M. KOYEMANN, Charlottenstrasse, 112 Dusseldorf, Germany; representative for Germany, Belgium, Holland, Switzerland and Austria-Hungary.

Spennrath, director of the Technical School of Aix-la-Chapelle, lately won the $2,000 prize offered by the Society for the Advancement of the Industrial Arts for the best essay on Protective Paints. The prize was not won simply by theoretical demonstrations, although the Professor furnished scientific reasons also, but by most carefully conducted practical experiments with various pigments and oils, covering several years' time. The results demonstrated that a properly made paint of graphite and boiled linseed oil is the most suitable for protecting structural iron work, roofs, etc., exposed to the destructive agencies of heat, cold, storms, etc. Those interested should write to the Joseph Dixon Crucible Co., Jersey City, N. J., for circulars.

* * *

MACHINERY in motion will prove one of the strongest departments and popular attractions in the 1897 American Institute Fair. The Fair managers are striving to make the 1897 fair the most important and best in the Institute's long and honorable record. The American Institute is verging on its seventieth year, but judging from the hustling the Board of Managers and the Fair's general superintendent, Mr. Alfred Chasseaud, are doing, the Institute is like Dr. Oliver Wendell Holmes, who said he was "seventy years, young."

The Fair this year will be of unusual value to exhibitors, providing, as it will, forty exhibition days, and features of unusual interest will insure a large attendance. The flower show adjunct alone will be in several respects the most beautiful, complete and costly ever held in the United States.

* * *

WE have received the announcement of the Cornell University Summer School, which we are sure will greatly interest any mechanic who wishes to advance. The courses given are, so far as we know, the only ones of the kind offered in this country where a bright engineer or machinist can, without passing any preliminary examinations, obtain six weeks instruction in drawing and machine design, and go through a practical course in the testing of steam, gas and oil engines, water motors, strength of materials, heating value of coals, and in fact the entire range of experimental engineering.

* * *

BUSINESS.

NO CHARGE IS MADE FOR THE INSERTION OF BONA FIDE ITEMS UNDER THE ABOVE HEAD. FOR FURTHER PARTICULARS, ADDRESS THIS OFFICE.

ROBERT GRIMSHAW, 9 Kaiserstrasse, Dresden, North Germany, needs a machine for bending angle iron 100 x 100 x 15 millimeters. Could also use a six-spindle drill for the girder section.

* * *

MANUFACTURERS' NOTES.

THE DAVIS & EGAN MACHINE TOOL CO., of Cincinnati, O., have just received a large order from the Government for lathes, shapers, drill presses, etc., to be used on the United States dredge boats in the Mississippi River.

THE new catalogue of the Waterbury Farrel Foundry and Machine Co. contains over 300 pages and 259 illustrations of machinery. In view of the fact that prospective customers for any class of machinery are not likely to be interested in other kinds of machines than the particular line for which they inquire, they have adopted the plan of printing a catalogue in sections, thus: Section A will be devoted to automatic rivet machines and special heading machines; section B, brass-butt and steel hinge machinery; section C, cartridge machinery; section D, chain draw benches for drawing tubing and rods; section E, foot, drop and screw presses; section F, forging drops and trimming presses, etc., etc.

* * *

FRESH FROM THE PRESS.

The Entropy-Temperature Analysis of Steam Engine Efficiencies. Sidney A. Reeve, M. E. Progressive Age Publishing Co., New York.

This consists of a blank chart with explanations and directions to enable the engineer to apply it to his particular case, in determining the efficiency of his engine. The origin of this method of steam engine analysis is credited to Prof. Gibbs, of Yale, and the explanations given seem to make clear this generally difficult subject. We believe the earnest students of the steam engine will appreciate this book.

The Mechanical Arts Simplified. D. B. Dixon. Laird & Lee, Chicago. $2.50.

This is a compilation of a variety of information for about all classes of mechanics, from architectural iron work to refrigerating machines and electrical apparatus. There seems to be a desire to simplify calculations, which is commendable, and in fact the whole book seems to be written for those who have not been fortunate enough to secure advanced education. It contains many tables which are of use when looking up the various subjects discussed, and we believe most mechanics can get considerable information from the book as a whole. There are a few points which might be criticized, but as we know the difficulty of getting everything just as it should be, in a book of about 500 pages, we refrain from mentioning the few points in question. As a whole we believe it is a book which will be appreciated.

Directory of the Mill Trade and of Large Buyers of Textile Fabrics. Textile World, Boston, Mass. 360 pages.

Full of information concerning the textile industry and collateral branches. It contains a complete directory of all the textile establishments in the country, with detailed information concerning each mill, what it makes, capacity, etc. All the mills in a city or town are grouped together according to location, while in another part of the book, alphabetically arranged, the different kinds of mills, viz: cotton mills, woolen mills, etc., are grouped by themselves.

A unique feature of this Directory is the textile maps of the principal manufacturing States. These maps show the location of cities and towns where there are textile establishments. The text of the Directory refers to the maps, giving railroad connections, distances, etc.

* * *

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

STILES & FLADD PRESS CO., Watertown, N. Y. Catalog of presses, drop hammers and dies.

This is an interesting catalog showing the different styles of presses made by this company, as well as some of the details. Quite a variety of tools are shown, together with sub-presses, drop hammers, copy baths and letter presses.

HOLDEN & BROOKE, Ltd., Sirius Works, West Gorton, Manchester, Eng. Steam specialties.

This illustrates several forms of "steam dryers" or "anti-primers" (steam separators) traps, reducing valve, injectors, ejectors, back pressure valves, etc. They are interesting as showing English practice in these lines.

THE WESTINGHOUSE MACHINE CO., Pittsburg, Pa.

As with all Westinghouse literature, this is a model of neatness, secured by the combination of good cuts and good paper. The illustrations show different installations of Westinghouse engines. The descriptive matter is brief and to the point, making a very attractive combination.

J. M. CARPENTER TAP AND DIE CO., Pawtucket, R. I. Catalog No. 11 B.

This is devoted to screw cutting tools for bicycle work. Among the special features of the catalog are the bicycle taper taps, made especially for repair work, a set of three taps taking any size hole, from one-quarter to five-eighths in diameter, a much larger range than is usually found.

TOLEDO MACHINE & TOOL CO., Toledo, O. 1897 Catalog of punching presses.

This is a 138 page catalog devoted to machinery for working bar and sheet metals, and shows a variety of these machines, which is sort of a revelation to the mechanic who is not familiar with this class of work. It is difficult to describe a catalog of this kind, as there are so many different tools of interest, the details of which would fill several pages.

THE JEFFREY MFG. CO., Columbus, O. Catalog of chain belting, elevating and conveying machinery.

This is uniform with their previous catalogs, but is brought up to date, showing their latest appliances and containing illustrations of some of their recent installations. They make about everything that is called for in the conveying line.

MACHINE DESIGN TAUGHT BY MAIL.

CORRESPONDENCE INSTRUCTION enables any man who will study to secure the technical education necessary to advance in his trade or profession. His studies need not take time from his work, but may be carried on at home. Specially prepared Instruction and Question papers take the place of text books and are furnished free. The instruction is thorough and practical. Our methods are successful. The schools have received the endorsement of Engineers, Machinists and Mechanics everywhere.

WE ALSO TEACH Steam Engineering—Stationary, Locomotive, or Marine; Electricity; Civil Engineering in all its branches; Coal and Metal Mining; Architectural Drawing and Designing, Plumbing and Heating; English Branches; Shorthand; Book Keeping and Business Forms.

MENTION THE SUBJECT in which you are interested and we will send you a Free Circular of Information containing a full description of the method of teaching, showing how admirably it fills the wants of those who cannot attend technical colleges. It also contains prices and terms, sample pages of the Instruction Papers and a reduced specimen of a drawing plate. Write to,

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Box 980, Scranton, Pa.